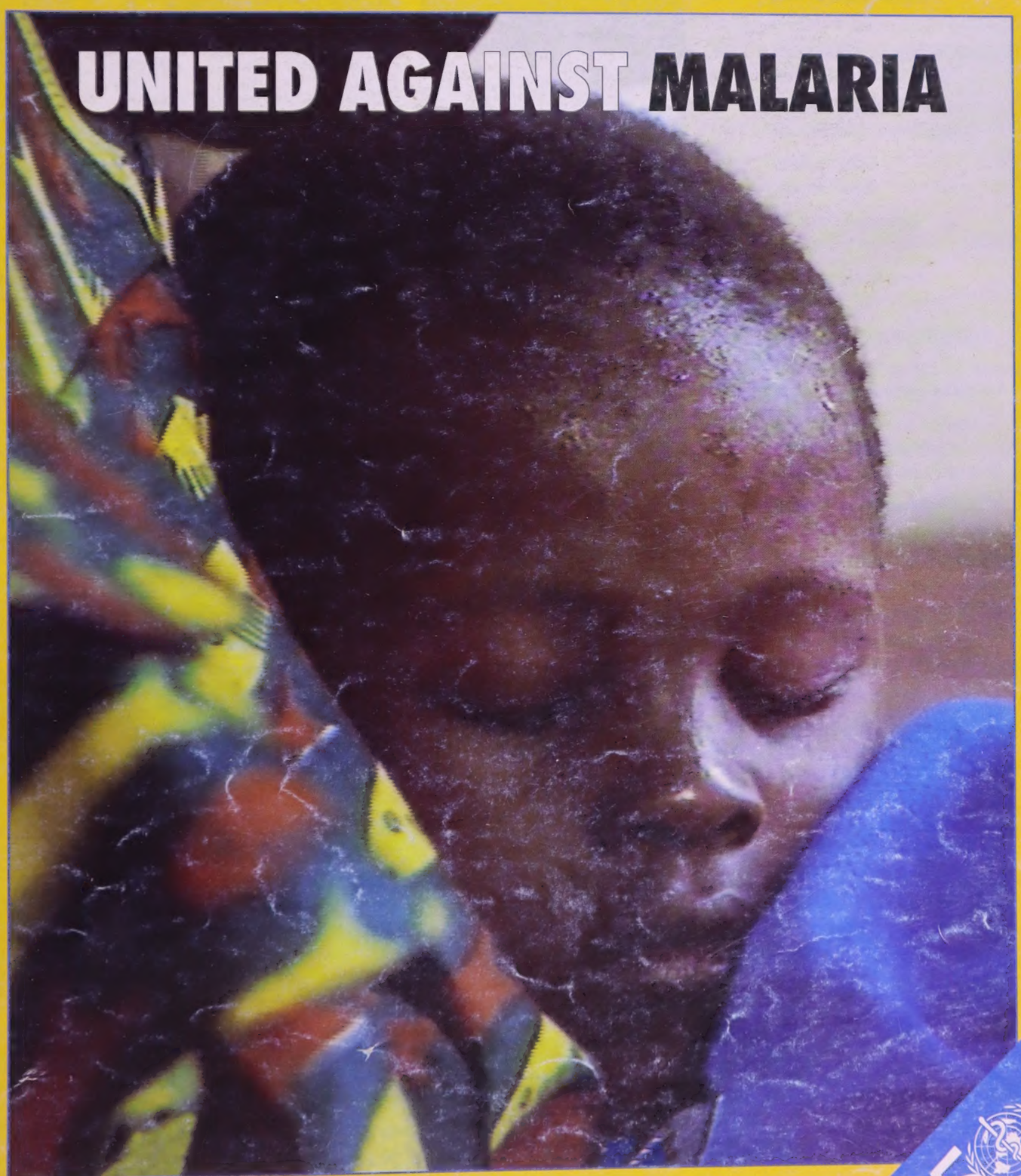
WORLD HEALTH

THE MAGAZINE OF THE WORLD HEALTH ORGANIZATION

51st YEAR, No. 3, MAY–JUNE 1998

UNITED AGAINST MALARIA



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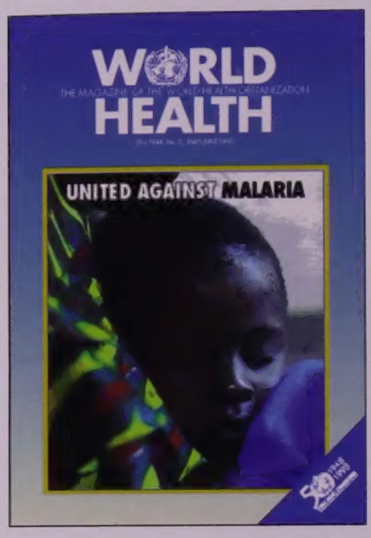

Cover: WHO/H. Anenden. This image is from the WHO film Do we still need to die of malaria?

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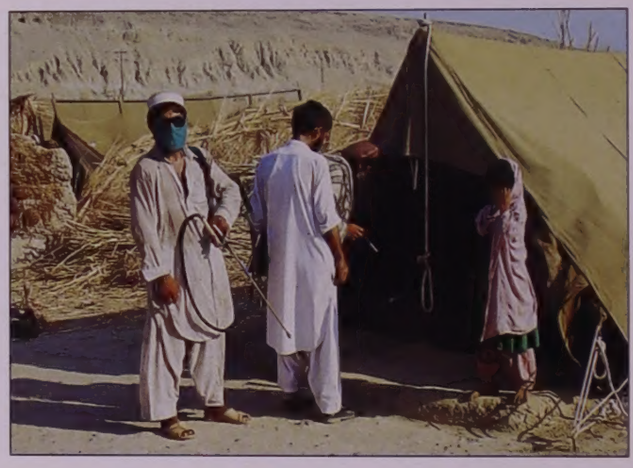

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Editorial

United against malaria

Dr Hiroshi Nakajima, Director-General of WHO. Photo WHO/H. Anenden

At first it seemed simple. If DDT and other insecticides were sprayed in sufficient quantity where the malaria vectors lived and bred, the disease could be eradicated within a few years. It took 15 or 20 years – from the 1950s up to the late 1960s – for governments and the international community to learn that global eradication was not possible, at least for the foreseeable future. The mosquito and the parasite it carried had proved far more difficult to control than anyone had imagined. WHO's Global Malaria Eradication Campaign achieved some notable successes but it also proved that, without a much more flexible and variable strategy combined with poverty reduction, self-reliance and sound environmental management, the war against this disease could not be won.

The eradication effort was gradually replaced by strategies emphasizing protection against infection and reduction of its severity. These have proved difficult to implement, however, with the scarce resources made available for them nationally and internationally, and at present up to two million people die of this disease every year.

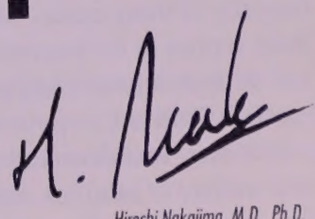
In 1992 WHO, other United Nations bodies and the malaria-endemic countries adopted the Global Malaria Control Strategy. Nearly all the countries concerned are now carrying out national plans of action within the framework of the strategy, which favours a combination of approaches adapted to national and local needs and resources. WHO has recently contributed an additional US$20 million to malaria control activities in Africa, where 90% of the deaths occur.

Global malaria control still requires a much greater effort, however, both in scientific research and development and in the mobilization of human and financial resources. More effective technologies are needed to control vector populations, prevent and cure malaria and reduce drug resistance, but the full potential of existing approaches is still far from being realized. Individuals and communities, when adequately informed and equipped, can themselves provide a large amount of the protection they need through such measures as eliminating breeding sites near the home and using impregnated mosquito nets. Health care workers at primary and referral level can, with the right kind of training and sufficient supplies, greatly reduce the severity and duration of malaria infection through appropriate case management.

At the same time, as I have stressed on many occasions, the incidence of a disease such as malaria is an indicator of poverty, unacceptable living standards and social injustice. To be effective, prevention and control activities must include the reduction of these underlying causes of disease. This requires a major multisectoral effort both nationally and internationally. While fulfilling its own responsibilities in the field of research and public health, WHO has been campaigning for many years to gain the political support needed for such an effort. This work is being vigorously pursued and expanded by WHO's next Director-General, Dr Gro Harlem Brundtland, who takes office in July. The "Roll Back Maleria" initiative emphasizes health services development and multisectoral collaboration, and is being spearheaded by Africa.

The Organization of African Unity, at its meeting of Heads of State last year in Harare, Zimbabwe, pledged its full commitment to a plan of action for malaria control in Africa. Asia has also taken up the challenge. Following these initiatives, the Group of Eight at their Summit this year in Birmingham, UK, issued a joint communiqué in which they supported a commitment to halving the numbers dying of malaria by the year 2010 and halving them again by 2015.

I am greatly encouraged by the preparations now under way to expand and intensify the fight against malaria on all fronts. With its rich store of experience to draw on, and with the cooperation of all its partners in health and development, WHO can demonstrate that malaria control is achievable in all parts of the world. ■



Hiroshi Nakajima, M.D., Ph.D.

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The Global Malaria Control Strategy

Peter Trigg & Anatoli Kondrachine

Clearing land for agriculture in Brazil. Malaria is a common occurrence in remote areas, with poor housing and a lack of basic services. Photo WHO/TDR/D. Sawyer

Malaria control is everybody's business. It involves not only health work and science but education, the environment, water supply, sanitation and community development.

Malaria kills between 1.5 and 2.7 million people each year, and between 300 and 500 million others fall ill from it, often severely. Over a million of these deaths are in children aged under five but they also include women in their first or second pregnancy, older children, young adults and non-immune travellers. Tropical Africa accounts for the overwhelming majority of these cases. Malaria is most serious in the poorest countries and in populations living under the most difficult and impoverished conditions. It undermines the health and welfare of families, endangers the survival and education of children, debilitates the active population and impoverishes individuals and countries.

Armed with DDT and other insecticides and the affordable drug chloroquine, WHO led a global campaign to eradicate malaria between 1955 and 1969. In sub-Saharan Africa the effort was focused on Ethiopia, South Africa and Southern Rhodesia (now Zimbabwe), since eradication was considered not yet feasible in the other countries. The attempt was unsuccessful, though much was accomplished and the disease was eradicated from the industrialized countries in which it was endemic, and large areas of subtropical Asia and Latin America were freed or practically freed from it.

The main lesson learnt from the eradication effort was that the disease could not be controlled by a centralized campaign based on using the same approach in all situations. Today, when we have much more respect for the capacity of the mosquito and the parasite to withstand our efforts, and a better understanding of the social and economic factors involved, a new strategy is being pursued.

The Global Malaria Control Strategy was designed by health workers from the malaria-endemic countries and endorsed, first at a Ministerial Conference on Malaria Control convened by WHO in Amsterdam in 1992, and then by the United Nations General Assembly in 1994. An Action Plan to implement it, developed by WHO in collaboration with other United Nations organizations and agencies, was adopted by the Economic and Social Council of the United Nations in 1995.

Control is everybody's business

In contrast to the eradication effort, the Global Strategy recognizes that malaria problems vary enormously from country to country, from area to area and even within different groups of the population. Control efforts must be adapted accordingly if they are to succeed. The aims of the Strategy are simple – to prevent people from dying from the disease and to reduce the suffering and the social and economic damage it causes.

This is possible because malaria is a curable and preventable disease. But since many of its causes and their remedies lie outside the health sector, the Strategy calls for malaria control to become an integral part not only of general health programmes but also of the relevant development programmes in other sectors. Malaria control is everybody's business and everyone should contribute. It requires the partnership of community members and the involvement of those engaged in education and the environment in general, and in water

This young boy is having his temperature checked. A fever could indicate malaria. Regular assessment of the malaria situation in countries is part of the Global Strategy against the disease. Photo WHO/TDR/A. Crump

supply, sanitation and community development in particular.

It is not an easy task. Malaria often occurs in remote areas, with poor housing and a lack of basic health services. Crowding, migration, rapid and uncontrolled urbanization, war and civil disturbances compound the difficulties. Scarce resources have to be used to deal with emergencies. In many countries, the majority of cases of malaria are diagnosed and treated in the home or by private sector practitioners, often incompletely and with irrational regimens. This speeds up the spread of parasite resistance to antimalarial drugs, and thus poses another major problem. It has, for instance caused a dramatic rise in the cost of drugs for treating an uncomplicated case of malaria: from about US$ 0.15 to over $ 2.00 in parts of the Indochina peninsula and in the Amazon region of Brazil.

Nevertheless, progress is at last being made. By mid-1997, 47 of the 49 malaria-endemic countries in Africa had completed national plans of action for malaria control in line with the Global Strategy. In 1997 $ 10 million was provided by WHO to accelerate the implementation of these plans in 24 countries of Africa. An additional $ 10 million was contributed in 1998 to expand antimalarial activities. Outside Africa, 57 malaria-endemic countries have reoriented their control programmes according to the Global Strategy. Thus, the target set in 1995 that, globally, over 90% of countries affected by malaria should be implementing appropriate malaria control programmes has been met.

More sustainable protection

Formerly, malaria control depended heavily on insecticide spraying, but now the selective use of protection methods, including vector control, is proving to be more cost-effective and more sustainable. House-spraying is now restricted to specific high-risk and epidemic-prone areas, and increasing use is made of insecticide-impregnated mosquito nets.

In WHO's Western Pacific Region, treated nets are a regular feature of malaria control in situations where they have been shown to be effective. In these areas, large numbers of people are protected by ecologically safe methods, and the decrease by as much as 80% in the amount of insecticide needed means a major saving of resources. Large-scale trials of insecticide-treated nets in different epidemiological settings in Africa have shown that reductions in overall child mortality of 15–33% can be achieved, but the challenge facing malaria-endemic countries of Africa is to translate these findings into sustainable programmes.

When the Strategy was adopted it was recognized that new skills would be required if the general health services were to take responsibility for diagnosis and treatment. Managers have to adapt the Strategy to local situations, existing malaria staff have to 'unlearn' practices that are no longer effective, and communities need to learn about malaria and how to deal with it. Training and health education are therefore major priorities. WHO has developed an international programme to train trainers. These trainers are then responsible for in-country training of district health officers and their teams, and the community. The collaboration between WHO, the World Bank and UNESCO in devising education materials and information for the media, and in the training of teachers and other education personnel, is proving invaluable.

The Global Strategy is beginning to have an impact on malaria morbidity and mortality in a great many countries. It is also allowing other countries to maintain their malaria-free status. The lesson is clear: malaria can be controlled by using the tools that are currently available. The challenge now is to make the fullest use possible of these tools in Africa where there are high levels of morbidity and mortality. Meanwhile, research and development must be continued and strengthened so as to provide new approaches as the malaria situation evolves. ■

Dr Anatoli Kondrachine is Chief of the Malaria Unit, Division of Control of Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland, and Dr Peter Trigg is a Scientist in the same Unit.

THE GLOBAL MALARIA CONTROL STRATEGY

The strategy has four basic elements:

- to provide early diagnosis and prompt treatment;
- to plan and implement selective and sustainable preventive measures including vector control;
- to detect early, contain or prevent epidemics;
- to strengthen local capacities in basic and applied research to permit and promote the regular assessment of a country's malaria situation, in particular the ecological, social and economic determinants of disease.

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What is malaria?

Kevin Marsh & Catherine Waruiru

Malaria is a great imitator and the only safe rule, if you live in or have visited an area where malaria is known to exist, is to consider every fever as a potential case of the disease.

As it feeds on human blood, the **Anopheles** *mosquito transmits the malaria parasite. Photo WHO/TDR/N. Wilmore*

Malaria is caused by infection with a microscopic parasite and is transmitted to humans by the bite of certain sorts of mosquito called anophelines. The parasite is not simply transferred from person to person but must live part of its life in the mosquito.

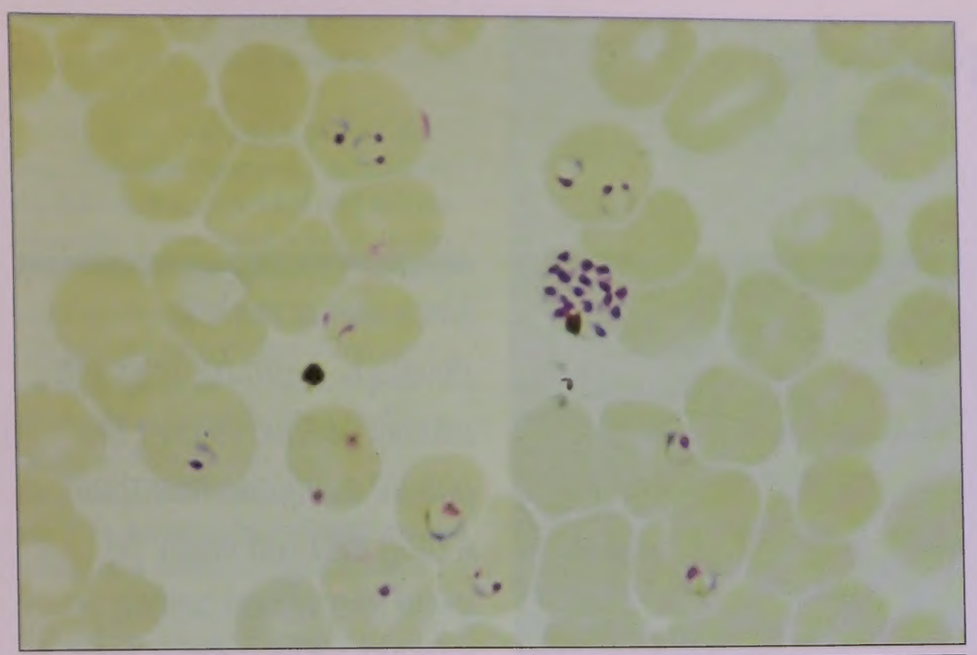
Life inside the mosquito is a race against time, because the time taken for the parasite to go through its growth and development is close to the average lifespan of the insect. This period is longer in cooler environments and shortens as the temperature rises. Thus the survival of the parasite is on a knife-edge, and once the average temperature drops below a certain point the mosquito tends to die before it can transmit malaria. It is for this reason that malaria is such a threat to health in the tropics but not in cooler countries or at high altitudes (where the temperature is lower). One of the many threats posed by global warming is that it could extend the territory in which malaria is a health problem.

How the parasite invades the body

The malaria parasite is injected into humans in the saliva of the mosquito when it feeds. Once in the human, the parasite at first causes no symptoms but enters the blood stream, travels quickly to the liver and then hides there while it grows and divides. After a period of nearly two weeks, the new daughter parasites burst out of the liver and enter the blood stream where they invade red blood cells. The parasite now enters a cycle of rapid multiplication; every 48 or 72 hours (depending on the species of malaria) the newly formed daughter cells spew out of the red blood cells and invade new ones. By this means an infection that begins with a small number of parasites can, over a few days, produce tens of thousands of millions of daughter parasites.

Small wonder that at this point the human host begins to feel ill. The first signs are usually fever and a general feeling of aching and being unwell, often with a bad headache. Many people who have had malaria feel that they can tell it from other illnesses, but this is a dangerous belief. In reality, at this stage malaria is easily confused with many other common illnesses such as an attack of flu. Other symptoms such as cough, vomiting or diarrhoea may lead the patient or health care personnel to think the problem is a chest infection or a stomach upset. Malaria is a great imitator and the only safe rule, if you live in or have visited an area where malaria is

One of the many threats posed by global warming is that it could extend the territory in which malaria is a health problem.



Plasmodium falciparum, *the most dangerous of malaria parasites, under the microscope. Photo WHO/TDR/ W. Trager*

known to exist, is to consider every fever as a potential case of the disease. High levels of awareness and rapid appropriate treatment are the keys to preventing the disease from developing to the dangerous state of severe or complicated malaria.

If treatment is not started quickly the patient gets more ill. The symptoms are caused by the destruction of red cells, causing anaemia, the release of toxins into the bloodstream as the parasite bursts out of the red cells, and the blocking of small blood vessels throughout the body. The patient becomes weaker; danger signs include persistent vomiting, becoming confused, increasing difficulty in breathing, or having an epileptic fit. The patient may become unconscious, a condition known as cerebral malaria. Any of these symptoms is a sign of a serious problem and the patient needs urgent admission to a hospital or health centre with the facilities for good inpatient care.

Many people who have had malaria feel that they can tell it from other illnesses, but this is a dangerous belief.

Prevention and information are the key

Different age groups are more affected or less affected by malaria in different regions. In areas of high transmission, people eventually develop some degree of immunity; the major threat is to children and pregnant women. This is especially so in sub-Saharan Africa, where a million or more children are thought to die of the disease every year. In areas of less intense transmission all ages are susceptible. Prevention is better than cure, but this is not always possible. Once someone has the disease, the key to avoiding the life-threatening complications is early recognition and treatment of fevers. Unfortunately, in many areas of the world, communities lack both the information and the resources to do this. As long as this is the case, malaria is likely to continue to be one of the great scourges of humankind. ■

In areas of high transmission, people eventually develop some degree of immunity; the major threat is to children and pregnant women.

Professor Kevin Marsh and Dr Catherine Waruiru are with Wellcome Trust Laboratories, KEMRI Coastal Unit, P.O. Box 230, Kilifi, Kenya.

A doctor takes a blood sample from a child's finger. The presence of parasites in the blood will confirm the diagnosis of malaria. Photo WHO/TDR/S. Lindsay

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Severe malaria

Malcolm Molyneux

At a hospital in the United Republic of Tanzania, a mother watches as her child lies in a coma with severe malaria. Photo WHO/TDR/A. Crump

Once severe malaria develops, extra facilities are usually needed to give the patient adequate treatment. A drug that can easily be given in a village setting, perhaps while waiting for transport to carry the patient to a hospital, can be life-saving.

At a rural clinic in tropical Africa, it would not be unusual to find each of the following patients waiting for attention:

- a man complaining of feverishness for the past two days; he is still able to work, but wants treatment to make him feel better;
- a child whose mother is worried because the boy's hands and lips have become almost as pale as paper, and he seems less energetic than usual;
- a young girl who is hot, deeply unconscious and having repeated convulsions of the whole body; her brother died the previous year during a similar illness.

Each of these patients is suffering from malaria. For the first, it is simply a nuisance; for the second, profound anaemia has developed, which could be fatal if untreated; for the third, the function of the brain has been affected and the child is in danger of losing her life. We refer to the illnesses in the second and third of these individuals as different forms of severe malaria.

Why can malaria parasites cause such different kinds of illness in different people? We know some of the contributing reasons.

- The species of malaria parasite is important – only *Plasmodium falciparum* causes severe disease, in some people – and we believe that there are differences even between strains of *P. falciparum* in their capacity to cause disease.
- The immunity of the individual also affects how ill a person becomes when infected with malaria parasites. The first patient described above was probably protected by immunity acquired slowly over years of repeated infection. We also know that some people are genetically less susceptible than others to severe illness when infected with *P. falciparum*.

Which individuals in a community are most at risk of severe malaria? This depends on their exposure to the infection. Where transmission is intense, everyone is infected in early childhood and some of those children develop severe disease, which may prove fatal. Over a million children die every year in this way. In such populations, those surviving to adult life have acquired some immunity, and tend to suffer only mild illness when again infected with the parasite.

Low immunity

Where transmission is only occasional, or occurs only in some parts of a country, people do not have the opportunity to become immune; malaria is a less common problem, but people of all ages are at risk of severe disease if they become infected. Similarly a traveller from a non-endemic country is at risk of severe disease when visiting an area where *P. falciparum* is transmitted.

Prompt and effective treatment may prevent a malarial fever progressing to severe disease, or may save the life of a person who has already developed severe malaria. For many of the people most at risk of malarial infection, getting good treatment quickly for a fever can be difficult or impossible. This is the story told by the mother of a child brought in unconscious one evening

to a hospital in a country where there is intense year-round transmission of *P. falciparum*.

"B. was completely well yesterday (Tuesday) morning. At midday he did not want his food and felt hot to touch. I wondered whether to go to the clinic, but the mobile clinic is only on Mondays and Thursdays, and the health centre is five kilometres away, it was raining heavily and there is no transport. So I bought a tablet of chloroquine from the grocery shop, and forced him to swallow it. This morning he was still hot and weak, and then his whole body started jerking. So I took him to our village healer, who applied a mixture to the child's head. As he remained unconscious for many hours, my brother helped me to carry him to the health centre by bicycle. The nurse at the health centre said B. needed an injection of quinine, but it was out of stock. She ordered an ambulance, which arrived after about four hours, and it took an hour to drive us here."

In hospital this child was immediately given an infusion of quinine, together with glucose and fluids. Further seizures were treated with anticonvulsant drugs, and he needed a blood transfusion for rapidly progressing anaemia. After 28 hours of continuing coma, he regained consciousness and made a full recovery.

Thousands of similar stories could be told every week. Often the outcome is not so happy: the child may die at home, or on the attempted journey to hospital, or in hospital because the treatment is administered too late. Some children who recover from a malarial coma are left with disabilities such as partial paralysis, deafness, blindness or mental impairment.

In the case of non-immune adults, severe malaria is often the result of delayed diagnosis of early symptoms. The delay may be due to patients assuming that they are suffering from some minor fever, or it may be due to doctors diagnosing a less dangerous condition such as influenza, bronchitis or hepatitis.

A patient with severe anaemia due to **Plasmodium falciparum** *arrives at a district hospital in Viet Nam. Transporting such patients as quickly as possible can save their lives. Photo WHO/TDR/O. Martel*

Education is the key

What can be done to reduce the burden of severe disease and death due to malaria? Education – by radio, at school or in village meetings – may help people to know the possible dangers of malaria and how they might reduce these dangers. Doctors and health workers at all levels need to be aware of when to suspect malaria and how to diagnose and treat it properly.

Preventing mosquitos from inoculating parasites into humans – for instance by the use of insecticide-treated bednets – has been shown to reduce the number of deaths in children. Such measures can have an important impact, although they cannot prevent all infections or all severe disease events.

Prompt treatment of malarial fever can reduce the chance of that fever progressing to severe malaria. This requires a treatment which is effective against the local strains of *P. falciparum* and available close to where people live. Where health services are distant, shopkeepers can help by stocking essential antimalarial drugs, provided they can give people the right advice about how to use the drugs properly. When health services are within reach, they need to have stocks of the necessary drugs, as well as staff who can recognize malaria and treat it correctly, especially if signs of severe disease are beginning to appear. Unfortunately, even with early diagnosis and treatment, malaria may progress to the severe stage

Once severe malaria develops, extra facilities are usually needed to provide adequate treatment. A drug that can easily be given in a village setting, while waiting for transport to carry the patient to a hospital, can be life-saving. Artemisinin compounds are used in this way in parts of south-east Asia and are being studied in Africa. Improved transport and communications will themselves improve access to treatment for people like the woman and her child described above.

Meanwhile vaccines against malaria are being tested. Some vaccines may prevent malaria of all kinds; others may simply reduce the risk of a malarial infection progressing to severe disease. We must hope that such a development will very soon add to our available weapons against the world's most destructive parasitic disease. ■

Professor Malcolm Molyneux is with the Wellcome Trust Centre and Malaria Research Project, P O Box 30096, Blantyre 3, Malawi, Africa.

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Impregnated bednets

Geoffrey A.T. Targett & Brian M. Greenwood

Insecticide-impregnated nets have been proved by a range of trials in different countries to offer one of the best malaria control measures available, provided they are used in the most appropriate way.

In a Chinese village, householders dip their nets in the insecticide deltamethrin to protect themselves from the bites of malaria-carrying mosquitos. Photo WHO/TDR/Y. Zhao

The past ten years have seen major changes that will affect our attempts to control malaria. Some of them are beneficial but others make it more difficult to implement the control measures that we have. On the debit side, parasite resistance to the few drugs available for the prevention or treatment of malaria has increased, in some cases quite alarmingly. Environmental changes and population movements have also caused the malaria situation to deteriorate. The regions of the world where there is the highest risk of malaria remain precisely those where the resources needed for control programmes are scarce or just not available.

On the positive side, some malaria control programmes are now better organized, partly as a result of the global control strategy agreed at the Ministerial Conference on Malaria held in Amsterdam in 1992. New drugs are being introduced, and clinical trials of a number of different vaccines are planned for the coming years. However, it is the beneficial effect of using insecticide-treated bednets and other materials, such as curtains to screen doors, windows and the eaves of houses, that has attracted the greatest interest. Here at last, it seems, is a method of preventing malaria that is simple, safe to use, and technically sustainable by local communities without the need for continuous expert supervision.

Encouraging results

The largest trials of treated bednets undertaken so far have been in China, and have contributed to a substantial reduction in malaria in some parts of that country. It is, however, in Africa – where more than 85% of the world's malaria cases and malaria-related deaths occur – that the results have been particularly encouraging. In a series of trials carried out in areas with different levels of endemicity, the number of clinical attacks of malaria in children protected by treated bednets was reduced by 30–60%. Even more dramatically, in one of the first trials (in the Gambia) overall child mortality was reduced by more than 60%. In subsequent trials elsewhere in Africa, the effects on mortality were not quite so dramatic, but there were still reductions of between 15% and 33%. All these studies were carried out in areas of stable malaria where control is the most difficult.

These are good results and it is tempting to believe that a large-scale expansion of insecticide-treated nets is achievable without too much difficulty. Health ministries in countries where malaria is endemic are now rightly planning to promote this strategy as part of their national malaria control programmes, and donor agencies are also in favour of it. However, the results that have been obtained so far come from carefully planned, highly organized, fully funded trials. Transferring these successes to operational programmes could prove more difficult.

Unresolved issues

Many important practical research issues still remain to be tackled in relation to the use of treated bednets. How best can nets and insecticide be made available to those who need them most? Can they be afforded by the populations of poor African countries? Should the nets and the insecticide be subsidized? Projects

aimed at answering these vital questions are in progress at many sites. There is also still a need to establish what quantity and strength of insecticide is best for a particular type of netting or a particular environment, and which pyrethroids are best; some are cheaper than others but are they as effective or as non-toxic for humans? Better tests are needed for routine measurement of the amount of insecticide on netting, and these will also determine how frequently re-treatment is needed. Different methods of packaging the insecticide need to be tried – for example, in single packs that can be used on individual nets after they have been washed. A matter for concern is the development in malaria vector mosquitos of resistance to the pyrethroid insecticides used for impregnation; this has already been detected in focal areas of Africa. How quickly will it spread? Improved methods for testing resistance are urgently needed.

Some experts argue that the trials show only short-term benefits and that clinical attacks and deaths are simply being postponed. It is generally assumed that the risk of severe malaria and death increases with the intensity of transmission by mosquitos, and the findings of some studies support this view. Others, however, have shown that the incidence of malaria increased with the intensity of transmission but only up to a point. Beyond that point there were no further increases in deaths or cases of severe disease, and perhaps even a decrease. If this turned out to be true for most situations, reducing transmission in regions where it was only moderate or low would be beneficial, but in areas of very high transmission this would not reduce the risk of disease and might even increase it.

Support for this view comes from two recent studies. An investigation of hospital admissions with severe malaria in five communities with different levels of transmission showed that the risks of severe disease in children were lowest in the populations with the highest intensity of transmission. Also, a major study on the use of treated bednets in Burkina Faso showed there was a significant drop in mortality in the first year after the intervention, but this was not apparently sustained into the second year. These observations call into question the long-term value of reducing the amount of biting by mosquitos by using treated nets or other means where biting is most intense. The questions should not be ignored, but it is difficult to count the bites by infected mosquitos in a given population and to estimate the death rate from the infection, since many deaths from malaria occur at home.

A closely related concern is that preventing bites from infected mosquitos by the use of nets may impair the development of immunity. This might be the case if treated nets prevented all infections but they do not, so in highly endemic areas people who use them are frequently found to have parasites in their blood. Recent observations suggest that, once established, immunity persists for longer than was once thought, and that adults acquire immunity more rapidly than children, so that delaying infection until later in life could help in the development of immunity.

The benefit of using insecticide-treated nets and curtains still clearly outweighs the risk, and they should continue to be a vital part of malaria control programmes. However – and it is an important qualification – we must recognize that what has been achieved so far only demonstrates the short-term benefit, and experience with use of treated bednets in Africa on a large scale is limited. In the planning of new and expanded programmes we must include measurement of long-term effects of the use of nets, such as changes in the patterns of severe disease and immunity, and whether mosquitos change their biting habits as a result of the use of nets, or become resistant to the insecticides being used.

Insecticide-impregnated nets provide one of the best malaria control measures we have. It is important to get the maximum benefit from their use for as long as possible by using them in the most appropriate way. ■

Testing the bednet's efficacy in the Gambia. Mosquitos are blown against the net and collected 24 hours later to check if all have died. Photo WHO/TDR/S. Lindsay

Professor Geoffrey A. T. Targett and Professor Brian M. Greenwood are at the Department of Infectious Diseases, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, England.

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A vaccine for malaria?

Howard Engers & Nina Mattock

A child receives the third and final dose of a malaria vaccine as part of a field trial to test its efficacy under African conditions. African children stand to gain most from an effective malaria vaccine. Photo WHO/TDR/A. Crump

Improved knowledge and the availability of new technologies give us reason to believe that vaccination against malaria is possible.

In the last decade, considerable progress has been made in the search for a malaria vaccine, and the turn of the century is expected to see one or more such vaccines being actively developed by the pharmaceutical industry.

Globally, malaria is a major public health problem. The story of mosquito resistance to insecticides and parasite resistance to drugs impeding malaria control is a familiar one. And while there are renewed efforts to combat malaria both through conventional and novel drugs and through vector control activities, an effective vaccine would constitute a powerful addition to these tools.

Natural exposure to malaria leads to the development of partial immunity in humans, but repeated reinfection is required to maintain this immunity. Inactivated sporozoites (parasite forms living in the mosquito which are infective to humans) have been shown to be highly effective at inducing immunity in humans. Unfortunately, it is not possible to produce inactivated sporozoites in the enormous numbers required to make this a feasible method of vaccination. However, we now have new technologies at our disposal. Nucleic acid-based DNA vaccine technology, for example, allows us to identify promising immunogenic molecules much more rapidly, and this considerably expands the number of potential vaccines. Novel adjuvants – neutral substances that enhance the body's immune response to antigens – are becoming available for clinical use. Other delivery systems (live vectors such as salmonella or vaccinia which incorporate antigen gene sequences, and DNA vaccines) are under development and starting to be evaluated in humans.

This improved knowledge and the availability of new technologies give us reason to believe that vaccination against malaria is possible.

What sort of vaccines are being developed?

The malaria parasite has a number of different stages in its life cycle (see figure on page 13). Candidate vaccines are based on various antigens derived from these different stages:

- *Pre-erythrocytic vaccines* prevent the malaria parasite sporozoite stage from entering or developing within liver cells. Such vaccines would prevent the severe and life-threatening consequences of malaria in non-immune individuals. About 20 human clinical trials with various *Plasmodium falciparum* pre-erythrocytic vaccine candidates have been conducted to date. One highly promising candidate, "RTS,S", is currently in field trials in the Gambia.
- *Asexual blood-stage vaccines* prevent the parasite merozoite stage from entering or developing within red blood cells. Immunity against the asexual blood stages of the parasite, which are responsible for the symptoms of malaria, would have a direct impact on disease morbidity and death in the individual but would not necessarily prevent people from getting infected. At least six asexual blood stage vaccines have been tested clinically or are currently undergoing human trials.
- *Transmission-blocking vaccines* inhibit development of the sexual stages of the parasite within the mosquito. The sexual forms of the malaria parasite develop in the red blood cells a few weeks after infection, and are infective for mosquitos biting infected individuals. With wide coverage these vaccines could reduce transmission of the disease in endemic regions by reducing the number of mosquitos infected. Several transmission-blocking candidate vaccines are already undergoing clinical trials for safety and immunogenicity in the USA.

Vaccines currently under development include:

- Vaccines based on cocktails of antigens (multicomponent vaccines). The first multicomponent synthetic peptide vaccine SPf66, developed by Dr Manuel Patarroyo in Colombia (repre-

senting three asexual blood stage antigens and a sporozoite antigen), is the most widely tested vaccine to date. It has given mixed results in field trials in South America, Africa and South-East Asia.

- Another multicomponent vaccine, engineered in attenuated vaccinia virus and expressing three pre-erythrocytic proteins, three asexual blood-stage antigens and a transmission-blocking candidate, gave limited protection in a human clinical trial in the USA.
- A third multicomponent asexual blood-stage vaccine under development by Australian scientists is currently undergoing clinical trial in Papua New Guinea.

Second-generation vaccines include those that contain modified malarial peptides or novel adjuvants; DNA vaccines (nucleotide sequences encoding the antigen in question), which have shown promising results in rodent models; and antitoxic or anti-disease vaccines.

Why is a vaccine for malaria proving so elusive?

We don't yet have a vaccine for any human parasitic disease. For malaria, there is the problem of not being able to grow malaria parasites in large enough quantities to make vaccines in the traditional way, either from live but weakened organisms or from crude antigen preparations. Hence the focus on synthetic peptides, recombinant proteins or DNA vaccines. One difficulty is that, in clinical trials so far, most vaccines have failed to live up to the potential they have shown experimentally in animal models. This situation may be overcome when novel, more powerful adjuvants for human use become available.

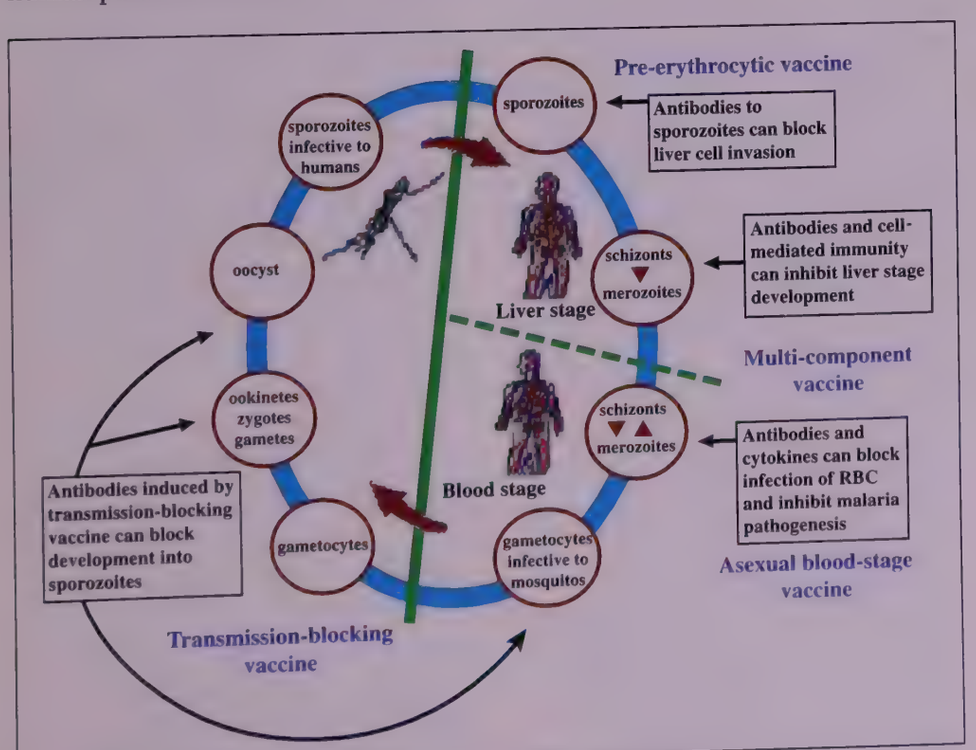
Then there is the difficulty of evaluation. The fact that there are no good *in vitro* surrogate screening systems to assess the efficacy of different vaccines in the laboratory is a significant limitation, and means that vaccines have to be tested experimentally, often in expensive, time-consuming animal model systems, including monkeys.

Another problem is that, unlike less complex organisms, parasites have developed ingenious ways of avoiding the host's immune response. For instance, the malaria parasite expresses different antigens at each stage of its life cycle, and is often able to change these antigens when the host mounts an immune response towards them. Different strains or isolates of the parasite can also express different forms of the same antigens. A multicomponent vaccine, aimed at covering several of the antigens, could overcome this problem but would be highly complex and difficult to develop. And finally, there is the complexity of conducting the clinical and field trials themselves, when researchers are confronted with measuring the reduction of morbidity and mortality following vaccination with a candidate vaccine.

Research on vaccines against malaria is mainly supported by a variety of international agencies, organizations, foundations and national funding agencies, including the governments of some countries and various research institutes. There is also greater involvement of the private sector when vaccine candidates have reached advanced stages of development.

Where do we go from here?

There is no guarantee that the current promising approaches to malaria vaccine development will result in a cost-effective malaria vaccine. Nevertheless, new technologies are becoming available and there is intensified political and financial support for research on malaria. The UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) is committed to evaluating the currently available leading *P. falciparum* malaria vaccine candidates in clinical trials by 2005. If all goes well, a malaria vaccine could be ready for use sometime in the next decade. ■



Different stages (in red circles) in the malaria parasite life cycle provide a range of targets for the vaccines. Graphic by WHO/TDR

Dr Howard Engers and Dr Nina Mattock are with the Special Programme for Research and Training in Tropical Diseases, World Health Organization, 1211 Geneva 27 Switzerland.

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Getting the community involved

V. P. Sharma

A communal effort to curb the proliferation of mosquitos by changing the environment. Initiatives like this have already reduced the malaria incidence in some parts of India. Photo WHO/V. P. Sharma

"Man-made" malaria posed a major headache for India's national antimalaria programme. Community participation became the mainstay of planning and interventions as local residents were spurred on by the hope of freedom from the disease.

In the early 1960s, the spraying of residual insecticides under India's National Malaria Eradication Programme eliminated malaria from three-quarters of the country. India was heading towards malaria eradication, and became a showpiece for the world. But then there was a resurgence of malaria in the 1970s, peaking to 6.45 million cases in 1976. To reduce morbidity and mortality due to malaria, a modified plan of operation was put into effect in 1977. Its three-pronged strategy consisted of government efforts, operational field research and community participation. For the first time, whole communities were involved as volunteers in drug distribution. Although cases had declined to two million by the 1980s, malaria control was faced with the problems of multiple vector resistance, resistance of *Plasmodium falciparum* to chloroquine (an affordable and safe drug), and the stubborn nature of transmission in certain areas.

Successive five-year plans transformed the country, making it self-reliant in food, and India emerged as a major industrial force in the world. Meanwhile, the mosquito vectors found new opportunities to proliferate in the irrigation tracts, industrial-scale farms and new towns which mushroomed, pulling in a large rural population. The "man-made" malaria that resulted accounts for more than 50% of the country's current malaria burden. Dealing with it has proved a formidable task, involving disease caused by new mosquito habitats, which we have categorized as irrigation malaria, industrial malaria, urban malaria, forest malaria and migration malaria. Control of resurgent malaria in these areas required local knowledge of how the disease is transmitted, while house-spraying – at one time considered a panacea – lost ground.

The malaria situation now called urgently for community involvement, as recommended by the Declaration of Alma-Ata and WHO's Global Malaria Control Strategy. Attacking the disease through community partnership had strong appeal but needed to demonstrate results. Community-based bio-environmental control projects were launched in a variety of different settings. Control strategies involved a combination of biological and environmental management methods, while community participation became the mainstay of planning and interventions.

The first project was launched in Kheda district, Gujarat State, in 1984, and before long 13 feasibility or demonstration projects had been established in nine states. The locations were selected for the range of problems they posed in relation to the vector, the parasite, the human ecology and the environment. From the very beginning it was realized that community participation required an understanding of local

Volunteers who help in distributing drugs are playing an important role in malaria control. Photo WHO/J. Schytte

Informing people of the risk of malaria. Communities which are aware of the basic facts about vector and parasite biology will collaborate much more enthusiastically in control efforts. WHO/V. P. Sharma

priorities, perceptions and behaviour patterns, as well as planning skills and financial support.

We started with fever surveillance followed up by prompt radical treatment. This activity reduced malaria, and provided an entry point into communities. Health education on various aspects of vector and parasite biology and on simple interventions proved to be the key to success. It was extended by means of exhibitions, demonstrations, lectures, group discussions, the distribution of popular literature, and talks on radio and TV. As a result there was a complete transformation in people's understanding about malaria, and we could see fresh confidence and excitement among villagers as old misconceptions about malaria were cleared up. Activities expected of the communities were simple, feasible and impact-oriented. They elicited full support and partnership so that the interventions were adapted to day-to-day village life.

The next step was to promote community action which was channelled through the village councils. Villagers were informed of our aims, objectives and methodology. Messages were disseminated by volunteers. Voluntary labour camps (*shram dan*) were used to improve drainage and level ditches, while eucalyptus and poplar saplings were planted in marshy areas. Voluntary agencies got involved, and the help of non-health sectors was mobilized. Cash donations poured in to support vector control. In Goa teaching about malaria and its control has become compulsory in schools. In some districts fish farming in village ponds generated funds which were used for drainage and vector control activities.

Although project staff were actively involved in organizing the interventions and monitoring, the communities were made to feel that any reduction in malaria and discomfort caused by mosquitos was mainly the result of their own efforts. To encourage the active involvement of communities, careful planning was done so that each person or group had the responsibilities for which they were most suited.

Finding a solution

As a result of these activities, mosquito breeding fell to a low ebb and was reflected by a drop in vector densities and in the incidence of malaria. In one area in the north-east of India, the interventions failed at first, as the primary health centre was in low-lying land prone to flooding, and the fish imported to eat mosquito larvae were eaten by the local inhabitants. The solution was to distribute mosquito nets impregnated with deltamethrin. Malaria incidence took a nose-dive and this prompted nearby village communities to demand mosquito nets, so a subsidized mosquito net programme was launched.

The enthusiasm for controlling malaria and the active involvement of the people could only be maintained through sustained efforts by an external agency, without which the activities tended to peter out. It was also observed that enthusiasm gradually faded with the disappearance of malaria, and communities changed their priorities. To sustain community involvement and at the same time to generate income, a holistic approach to rural development and malaria control was evolved. Income-generating schemes such as fish farming, planting trees in wasteland, finding alternative sources of energy, improving village sanitation and starting cottage industries were introduced and encouraged. To do this, various development agencies working in each area were invited to help, with well-defined objectives and a measurable impact.

While our experience of eliciting community participation varied from one place to another, the positive response largely depended on concurrent health education and the hope of freedom from malaria. In developing a partnership with the communities, we were able to keep community-based activities separate from local politics so as to avoid potential conflict. All told, our experience in malaria control has been positive and has filled us with hope for the future. It confirms our belief that community participation is indeed a rational and scientific approach to achieving sustainable malaria control with measurable collateral benefits. ■

Dr V.P. Sharma is Director of the Malaria Research Centre of the Indian Council for Medical Research, 22-Sham Nath Marg New Delhi-110054, India

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A brake on economic development

Bernhard H. Liese

Workers building a road through a forested area of Viet Nam. Construction works invariably leave water-filled pits where mosquitos can breed. Photo WHO/TDR/O. Martel

In the countries where malaria is endemic, improving living standards through economic advancement is virtually impossible without a sound malaria control policy and the allocation of appropriate funds.

Malaria is not just a major public health problem; it is also an important obstacle to economic development in most developing countries, particularly in Africa. Its spread is often linked to specific development activities such as road building, new agricultural expansion and irrigation projects. Road construction frequently results in water-filled pits being left alongside the new highway. In Papua New Guinea, after a road was built to link the coastal plains to the highlands, malaria epidemics suddenly occurred in previously malaria-free areas. The mosquitos carrying the malaria parasite had been keeping pace with the road construction, moving on from pit to pit.

In many places, malaria can fairly be described as an adverse social condition that is closely associated with economic development. In the most malarious part of the world, Africa, malaria has been a fact of life for millennia. But economic development has altered the patterns of transmission and in many cases has increased the already devastating impact of the disease. This means that the gains of development are often outweighed by the losses caused by malaria, both for individuals and families and for countries as a whole.

A national perspective

Malaria also undermines the effectiveness of investment in education. In highly endemic areas, the learning capacity of between 35% and 60% of all schoolchildren may be impaired. There are many reports to this effect. In the Solomon Islands, children lost 5.3 days of school each year, while school absenteeism in Zimbabwe was as high as 28%. Furthermore, when the main breadwinner dies or becomes seriously ill with malaria, the need for additional labour can easily result in a child's education being interrupted or abandoned. In Gezira, in the Sudan, a study showed that 62% of the work time lost due to malaria was compensated for by family members at the expense of household activities and schooling.

This disease has historically determined human settlement patterns in agricultural areas. For centuries, local populations have tried to avoid settling in malaria-infested lowlands and chosen instead the safer highland areas. It has been well documented in India that in the past malaria prevented expansion into new territories, resulting in substantial losses in earning power.

The governments of malaria-endemic countries allocate considerable funds, including scarce hard currency, to importing pesticides and equipment for control programmes. At the same time, the existence of malaria also limits a country's capacity to obtain foreign exchange, for instance, from tourism. It is difficult to attract tourists to malaria-infested regions, especially if they are known for recurring epidemics.

Local household perspective

The impact of epidemics on the economy of the local community or the household can be assessed as *direct costs* – the cost of treatment and control programmes – or as *indirect costs* – the value of income lost through disease and death. Estimates of days of disability due to a bout of malaria range from five to 20 days. Malaria infection often occurs more during the planting or harvesting season, when the wage level is higher, and this makes the loss in income even greater.

Direct costs incurred by malaria include the money paid by patients for care. In Thailand, for example, this amounted to US$ 20 per positive case, or nine times the average daily wage of the patients. In addition to the obvious direct monetary cost of treatment, a household also bears the cost of transport (which can be very

A health worker in the Brazilian Amazon distributes antimalarial drugs to new settlers, who are particularly vulnerable to the disease. Photo WHO/TDR/D. Sawyer

high for those living in remote areas), and for the time spent by relatives or family members who serve as carers. In rural Colombian households, it was found that treatment represented one-third of the cost of illness, and the time lost by the patient and carer the other two-thirds.

Researchers have estimated that families with malaria clear only 40% as much land for crops as similar families without malaria. The yield is generally 30% below normal despite the help given by family members, neighbours, children and sometimes hired workers. During an epidemic one would expect a further reduction in output.

Heavy toll

In summary, malaria accounts worldwide for 10–30% of all hospital admissions and is responsible for 15–25% of all deaths of children under the age of five. Some 300 million people are infected by it and up to 2.7 million people die as a result every year. Besides the harm it does to health, it severely impedes development and economic advancement. In many places it constitutes a factor that is closely associated with forced migration and the underdevelopment of rural areas.

It is difficult to make a realistic estimate of the financial loss caused by malaria to a given national economy. Some estimates suggest that a single bout of malaria costs the equivalent of more than ten working days in Africa. In 1987, a preliminary estimate of the total cost of malaria, including health care and lost production, was $ 800 million for tropical Africa; an estimate for 1995 was more than $ 1800 million.

All of this makes malaria control a priority for government resources. In the countries most affected, improving the living standards of ordinary people through economic advancement is virtually impossible without a sound malaria control policy and the allocation of appropriate funds. ■

Dr Bernhard H. Liese is Director, Health Service Department, The World Bank, 1818 H Street NW, Washington DC 20433, USA

Migration and malaria

Brazil's gold rush has brought an influx of young men in their twenties and thirties to the Amazon basin. Many of these would-be miners, the *garimpeiros*, come from the ranks of landless farmers and unskilled rural and urban workers. Most of them eventually quit the gold mines little better off than when they arrived. Only a very few strike it rich. While toiling in the *garimpos* they live in houses without protective walls, and they pay prices for basic goods which are four times higher than in the nearest town.

Most of them also suffer from malaria. Coming from the south of Brazil, they have never been exposed to the disease and it affects them severely. They take drugs for it – all kinds of drugs – but only until the symptoms are gone, and then they go back to work. They transport malaria with them when they return home to visit relatives or friends or when they find time to spend their savings, and then they trek back to the mines to start all over again. This situation is repeated in many frontier areas of the world where uncontrolled mining for gold or gems has become a major occupation – and where malaria runs rampant.

As this example demonstrates, malaria is closely related to the kind of migration that often occurs when alluring economic opportunities are perceived in a certain region.

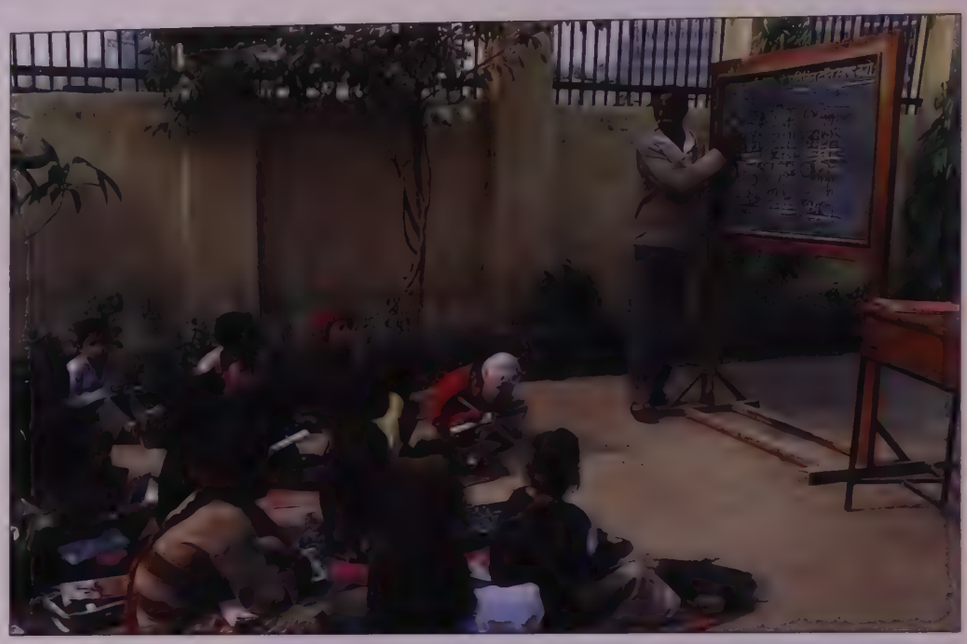
Mobilizing the teachers

Susan Van der Vynckt & Elil Renganathan

WHO and UNESCO join forces to fight malaria

Since education plays a major role in malaria prevention, the World Health Organization (WHO) and the United Nations Educational, Scientific and Cultural Organization (UNESCO) signed a Memorandum of Understanding on 2 May 1997 whereby the two organizations will collaborate in assisting countries to implement the Global Malaria Control Strategy by educating and protecting the health of children through the development of educational materials, the training of teachers and other educational personnel, and the elaboration of communication materials for the media.

The Memorandum forms part of WHO's efforts to implement the Global Malaria Control Strategy, developed in conjunction with national Ministries of Health. WHO's Division of Control of Tropical Diseases and UNESCO's Division of Basic Education, in cooperation with the science sector, will implement the Memorandum.



A city school in New Delhi, India. Teachers can fill their pupils with enthusiasm for making schools healthy places in which to learn and work. Photo J. & P. Hubley ©

In a number of communities, schools and teachers are already playing an active role in malaria control activities in and around their educational establishments. An ambitious health programme for schoolchildren in Zanzibar, for instance, is taking an integrated approach to the control of malaria and intestinal parasites, while in Zimbabwe the Ministries of Education and of Health and Child Welfare have incorporated malaria prevention in the school health policy and programme.

School malaria prevention programmes are a good example of how schools can make a signal contribution to community health and increase the outreach of primary health care. Indeed, prevention of malaria through schools can be a cost-effective public health measure with important educational benefits. It can also be a stimulus for the prevention of other common infections and illnesses as well as for environmental improvements which make schools healthier places in which to learn and work.

Malaria has too often been overlooked as a serious health problem for schoolchildren in endemic areas. While most teachers will be aware that many pupils suffer from it, they do not always realize the extent to which repeated attacks of malaria throughout a school year can reduce a child's chance of success. A UNESCO study in Kenya, covering six districts across the country, identified malaria as one of the leading causes of ill-health and school absenteeism. About a third of the children in malarious areas were absent during a given school term and more than half of them had two or more episodes of malaria in that period.

Teachers in the UNESCO study reported that children missed about a week of school for each bout of malaria, sometimes more, and when they returned to school they were often tired and lethargic. The situation in boarding schools was found to be much worse, owing to crowded sleeping arrangements in dormitories, lack of mosquito nets and screening on windows, and the generally poor environmental conditions. Malaria contributes significantly to a loss of school time, ill-health and poor performance by students.

Healthier schools

Controlling infections like malaria can only be successful and sustained if accompanied by efforts to make schools cleaner and healthier. It is important to demonstrate to pupils and the community at large how a clean and safe environment protects them from disease and illness. Teachers can do this, and the health education process depends on their input and commitment. However, many teachers lack the necessary training in health-related areas, so they need support and motivation through training, provision of teaching materials and recognition for their work.

WHO recognizes the important role of schools in promoting health and has launched a number of initiatives to encourage this and to use schools as entry points to reach the community. One such initiative is the UNESCO/WHO collaboration on protecting children against malaria.

Mounting a school-based malaria programme begins with an assess-

ment of the scale of the malaria problem in a given school population. Teachers usually record attendance in a class register and report absent children simply as "sick". With guidance from community health workers, they can be more specific in recording health-related absences. This can provide a basis for assessing common health problems and the pupils' health status, and for determining the school's overall health profile.

Teachers are both in contact with the community and part of it themselves, so they are well placed to gather information on prevailing beliefs and practices concerning common childhood infections and diseases – for instance, how parents treat sick children or how they protect them from disease. As regards malaria, it is important to understand what parents and carers consider to be signs and symptoms, when they believe it is necessary to seek care, how they apply treatment, and what they may be willing to do to prevent infection.

Upgrading the teachers' knowledge and skills in the health field involves developing simple training courses, preferably accompanied by support materials such as manuals and guides. In turn, they can learn to prepare health education materials for use in the classroom and with parents and other groups in the community. Being familiar with the local situation, teachers can help to tailor materials to local needs, and their involvement also makes it easier for them to incorporate the new subject matter into the curriculum.

School health education can be greatly enhanced with support from other channels of communication. Informed and trained teachers can initiate discussion in their schools with parents and other community members, and can encourage the broad dissemination of key messages through local radio, newspapers and cultural events.

A school-based malaria prevention programme that is carefully planned and carried out can demonstrate the effectiveness of using schools in support of essential services for primary health care. The aim should be to convince parents and communities that schools, whether rich or poor, can have a positive impact on the health of children and the whole community. ■

An open-air school in Africa. It is never too early to educate children about how malaria is transmitted and how to prevent it. Photo J. & P. Hubley ©

Dr Susan Van der Vynckt is Senior Programme Specialist, Division of Basic Education, UNESCO, 7 Place de Fontenoy, 75700 Paris, France, and Dr Elil Renganathan is Chief of the Training Unit, Division of Control of Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland.

School-based prevention of malaria

Goal	Health education	Expected outcomes
To disseminate messages and information which encourage prevention and ensure recognition of signs and symptoms and prompt treatment-seeking behaviour	1. Develop short teacher training courses on malaria prevention	Training courses and modules on malaria prevention
	2. Develop, in cooperation with teachers and community health workers, simple teaching/learning materials on early recognition, promotion of prompt treatment and effective preventive measures.	Teachers with health knowledge and skills
	3. Train teachers and other educational personnel (e.g., school supervisors, non-formal educators, etc.) and support them in actions to improve schools and to record salient information on pupils' health.	Educational materials
	4. Organize action to improve environmental conditions of classrooms and schools.	Healthier schools
	5. Include lessons on the life-cycles of the malaria parasite and the mosquito in the curriculum.	Children who know how malaria is transmitted and how to prevent it
	6. Link with parents and other community members to organize information for dissemination through local media (e.g., radio, newspapers).	Media involvement
	7 Involve teachers in monitoring health status through a regular school record-keeping system.	Monitoring and surveillance data

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Risks in motherhood

David Payne

An antenatal clinic in India. Pregnant women lose part of their natural immunity to malaria. Photo J. & P. Hubley ©

Malaria in pregnancy causes infant and maternal deaths and results in the delivery of underweight babies, who may be disadvantaged for the rest of their lives.

Malaria is the bane of motherhood. It can cause serious medical complications and death for the mother in pregnancy, it can blight the development of her child before and after birth and, all too often, it can be the cause of her child's death. It disrupts families and undermines their support systems. The control of malaria in a community is one of the most effective ways of improving the health status of women and children and the economic status of the society in which they live.

In highly endemic areas, frequent infection helps communities to build up natural immunity to malaria, though at an enormous cost in sickness and loss of life in early childhood.

In areas where malaria occurs only from time to time, high levels of immunity in the population are not maintained by frequent reinfection; the result is that large numbers of people of all age groups are seriously affected when an epidemic occurs. The risks associated with malaria infection in non-immune pregnant women in these areas are severe; they include spontaneous abortions in up to 60% of pregnancies, and deaths in up to 10% of pregnant women.

In highly endemic areas, for reasons that are not yet fully understood, women lose some of their acquired immunity to malaria when they become pregnant. This is particularly the case when it is their first pregnancy. In countries where the most serious form of malaria, caused by *Plasmodium falciparum*, is highly prevalent, such decreased immunity exposes pregnant women to serious danger of malaria infection, including life-threatening anaemia and miscarriage. The disease also results in the delivery of underweight babies – the "small baby syndrome" – with all the disadvantages this may entail in later life with regard to both physical and mental impairment. In some cases, the parasite can cross the placental barrier, resulting in babies being born infected with malaria. With subsequent pregnancies the risks of malaria infection diminish, but where there is HIV infection it interferes with the maintenance of pregnancy-specific immunity, and the mother and her unborn children remain at risk.

Normally the immunity of the mother returns quickly after she has given birth, and some may be conveyed to the child during pregnancy, but the baby's own immunity is slow to develop and does not provide sufficient protection until the child has suffered several attacks of the disease. Children who survive those attacks can be left physically impaired, temporarily or for life.

Malaria is not the only danger the child faces. Common childhood diseases such as measles, diarrhoea and respiratory infections can, when combined with the depredations of the malaria parasite, so weaken the child that it eventually succumbs to them and dies. Some one million deaths a year among children under five are attributed to malaria alone or in combination with other diseases.

Temporary "visitors"

An example of the social impact malaria can have was seen in some highly malarious areas of West Africa before antimalarial drugs became widely available. Often the children in these areas were not named until they reached their first birthday. It was so common for children to die in the first year of life that they were not properly integrated into the family until they had reached that age and obtained a substantial degree of immunity. They were considered as temporary "visitors" until the passage of time indicated that they could survive and were more likely "to stay".

Seasonal risks

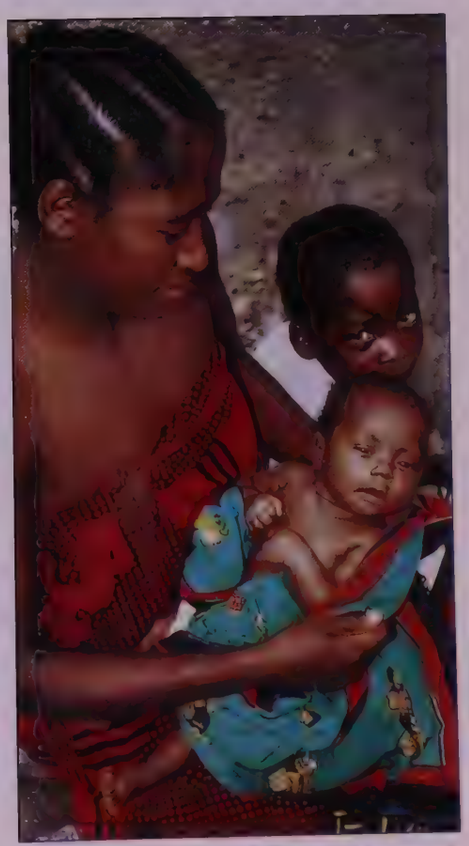
Another demographic aspect of the impact of malaria when combined with the childhood diseases is the readily observable fact that children born in certain months of the year often have a greater chance of surviving than the others. The highest death rates usually occur among children born three to six months before the main malaria transmission season. At three to six months of age they will have lost most of their maternal immunity but will probably not have had any malaria infections to build up their own acquired immunity. If the peak malaria season should coincide with the seasonal prevalence of one or more of the common childhood diseases, the impact is even more severe.

The mother may also suffer from economic deprivation as a result of malaria. Her own ability to feed herself and her children will be affected by successive pregnancies and the risk of more severe malaria attacks that undernutrition entails. In many developing countries, women bear a heavy load of economic responsibility through work such as cultivation, weaving, wood collection and water carrying. Moreover, the peak transmission seasons tend to coincide with the periods of planting and harvesting of crops. The failure of a family to maximize its own productivity and obtain additional resources in cash or in kind when work is most readily available can have long-term adverse effects on health and nutrition.

The ever-increasing cost of effective antimalarials is placing an added burden on mothers, particularly where government health budgets are severely limited; in the poorest countries governments spend only US$ 2 per capita per annum on health. Combined with political and economic instability and population growth, this makes the outlook for mothers in such countries increasingly worrying. To prevent the deleterious effects of malaria in pregnant women in endemic and epidemic areas, the only option until recently was to try to prevent mosquito bites, to treat infection immediately, or to prescribe antimalarial drugs such as chloroquine throughout pregnancy to prevent disease. Such chemoprophylaxis programmes are hindered by a number of constraints, including drug resistance and poor compliance, cost, availability, acceptability, and access to services. Similarly, treatment may not always be available in time. Recent studies indicate that a simpler regimen of intermittent treatment during pregnancy aimed at all women in endemic areas may be more feasible and effective. Such a regimen could be incorporated into existing antenatal care services, reaching a large proportion of the women and girls who need it. The international community should support such research efforts or campaigns that can lighten the burden on these mothers of the future generations.

The Global Malaria Control Strategy worked out by donor countries and malaria-endemic countries in 1992 is beginning to bear fruit in terms of national action plans. It is to be hoped that the choice of Safe Motherhood as the theme for this year's World Health Day will also be a catalyst for the further development of effective research and control programmes to protect expectant mothers and their unborn children from malaria. ■

Dr David Payne worked for the World Health Organization until his retirement. His address is 26 Clinton Road, Penarth, Vale of Glamorgan CF64 3JD, South Wales, UK.
This article is based on one he wrote for ***The World of Information Africa Review****, Health Care Supplement, Summer 1998. Modified and reproduced by permission.*

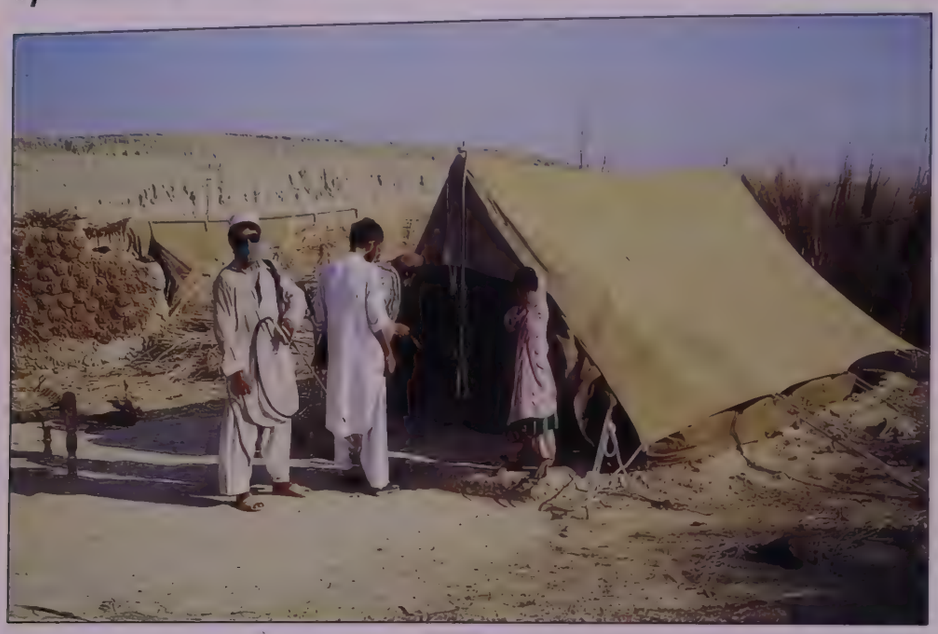


A mother waits for consultation in the United Republic of Tanzania. Common childhood diseases such as measles, diarrhoea and respiratory infections are even more dangerous when combined with malaria.
Photo WHO/TDR/A. Crump

World Health ■ 51st Year, No. 3, May–June 1998

Malaria in emergency situations

Sylvia Meek & Mark Rowland



Displaced persons in Afghanistan. Refugees who leave a malaria-free area to settle in a region where the disease is endemic have little or no immunity to protect them. Photo WHO/M. Rowland

In refugee situations, displacement may drive people with little or no immunity to malaria into high-transmission areas, so that they become much more severely ill than the local residents. Such a sudden influx of people can lead to major outbreaks.

Malaria is one of the killers of people fleeing from armed conflict in developing countries. Such populations are among the most vulnerable in the world, suffering mortality rates much higher than in their home territories. The number of refugees has increased in the last two decades, reaching over 20 million in the mid-1990s. There are even more internally displaced people – those who still live in their own country but have been forced to leave their homes: their numbers are estimated to be around 25 million. Less information is available on internally displaced people, because they are often in war-torn areas that relief agencies cannot reach, where health services are disrupted and security is poor. These factors increase the risk of severe disease and death from malaria.

Most of the countries where refugees and displaced people have been worst affected by malaria in recent years have been in Africa. They include Burundi, Democratic Republic of the Congo, Kenya, Malawi, Rwanda, Somalia, eastern Sudan and Zimbabwe. Asia has also had major population movements in malarious areas. From 1979 to the early 1990s, Cambodian refugees suffered heavy losses from malaria when they fled to Thailand. Many are internally displaced and still live in high-risk areas, and recently another wave of 45 000 people fled through areas of high transmission. Over three million refugees fled to Pakistan from Afghanistan in the early 1980s to escape the conflict, and many settled on malarious land.

The situations of displaced Cambodians and Afghans illustrate some of the special aspects of malaria infection in displaced people. Recognition of these can help us to avert the excessive loss of life which can occur in these conditions. When the Cambodians first fled to Thailand, many came from areas of low malaria transmission, but had to cross through jungles where the major mosquito vector is found. They arrived in Thailand exhausted, starving and infected with malaria, and the death rate in the first few months was extremely high until health services were established.

Breakdown of services

Prior to 1980, Afghanistan was one of the few countries in Asia that had successfully controlled malaria. When forced to flee to Pakistan, refugees with no natural immunity succumbed to the disease and then took it back to Afghanistan when conditions became more secure, leading to epidemics among the resident population owing to the breakdown in public health and malaria control services.

In Africa too, deaths from malaria have been particularly numerous among people with low immunity fleeing from highland areas where there is little transmission. Examples were the movement of Ethiopians into eastern Sudan in 1985 and of Rwandans into Zaire (now Democratic Republic of the Congo) in 1994.

The treatment of falciparum malaria was particularly difficult in the Cambodian camps, as the Thai-Cambodian border was the area of greatest antimalarial drug-resistance. This meant that health staff had little alternative at that time but to offer a seven-day course of quinine and tetracycline; this required 84 tablets for each adult, so that few people took the full course of treatment. In eastern Africa and south Asia, chloroquine resistance is spreading rapidly and some resistance to other drugs has been reported, so treatment policies are having to change. This increasing resistance not only puts the patients at greater risk but leads to more difficulties in keeping health workers and patients informed about the best treatment.

Despite this gloomy picture, much can be done to minimize the loss of life in these situations. Some of the key needs are an effective emergency plan, good information for health workers employed by relief agencies and for the displaced people themselves, and adequate funds from aid donors to carry out more aggressive control measures than can usually be afforded in the local area. The host country can sometimes offer valuable advice and help.

The malaria problem on the Thai-Cambodian border was brought under control partly through a comprehensive malaria control programme with effective diagnosis and treatment, more recently by the provision of mosquito nets treated with pyrethroid insecticide, and by targeted spraying programmes. In addition, several camps were moved away from the forest zones; if selection of sites is possible, this can be a very important control measure in certain environments.

Nets can be costly

When the Afghan conflict was at its height, insecticide-treated nets were the only possible defence against malaria. Despite the attention now being given worldwide to treated nets for malaria control, they are not necessarily the best solution during an emergency since they are expensive and, if imported, may take months to arrive. Moreover, their effectiveness depends on how self-disciplined people are in using them.

Emergencies require the vertical provision of aid, and malaria control under such circumstances may best be achieved by methods that would be unsustainable under normal conditions. The provision of insecticide-treated tents is a humanitarian measure that is operationally analogous to the annual DDT-spraying campaigns in the days when governments hoped to eradicate malaria. In chronic refugee situations, where the refugees have no independent livelihoods, spraying campaigns – whether of tents or of houses – may still be the most satisfactory approach to reducing malaria. Afghan refugees have long dwelt in compounds built by themselves from mud; indoor spraying with long-lasting residual insecticide has reduced the annual case-load of malaria by two-thirds. However, distribution of treated nets through the private sector may also help to do this, foster self-reliance and obviate the need for central government planning.

As these observations show, it is difficult to set out definitive recommendations for dealing with malaria during an emergency. The choices will depend on the evolving political situation, logistics and access, local drug resistance and the possibilities for vector control or personal protection. During the early, acute stages of an emergency, the first priority for malaria control is therapy and the prevention of malaria-induced deaths. Once health services are in place, attention should be focused on preventing further outbreaks or reducing transmission and morbidity through the selection of preventive measures appropriate to the culture and circumstances. ■

Dr Sylvia Meek is Head of the Malaria Consortium, London School of Hygiene and Tropical Medicine (with the Liverpool School of Tropical Medicine), Keppel Street, London WC1E 7HT, and Dr Mark Rowland is with HealthNet International MSF, 4 Karakul Lane, P.O. Box 889, University Town, Peshawar, NWFP, Pakistan.

Distribution of mosquito nets in a camp for displaced Cambodians. This simple measure can sharply reduce the incidence of the disease among this vulnerable population
Photo WHO/S. Meek

An African perspective

Lateef A. Salako

Getting drugs on prescription in Ghana. Successful treatment of malaria is possible if safe and effective drugs are widely accessible. Photo WHO/Goldschmidt

In Africa, alternative health care systems involving traditional healers, medicine vendors and spiritual healers are often more acceptable and affordable to ordinary people. The formal health services should be improved until they become the system of first choice.

Malaria is not a homogeneous disease but varies from region to region, from country to country and from place to place. Over 300 million cases are estimated to occur globally every year, and one to two million of these end in death. Malaria is responsible for 2% of the disease burden worldwide and 9% of this burden in Africa. The severe complicated form of the disease is most commonly found in Africa, and more than 85% of malaria cases and deaths occur in that continent. Although the disease affects all age groups, most of the deaths occur in children under the age of five years.

Yet malaria is an easily treatable disease, and practically all the deaths it causes can be avoided with the control tools currently available. A crucial component of the current global malaria control strategy, therefore, is the management of individual cases. This entails:

- prompt and accurate diagnosis;
- availability of effective, safe, acceptable and affordable drugs for treatment;
- rational use.

Diagnosis

For effective case management, diagnosis must be made promptly and correctly. In malaria-endemic countries, diagnosis is as likely to be made at home as in a formal health care facility. In the home, diagnosis is based on clinical features as interpreted by the mother or other carers or, in the case of an adult, by the patient or friends and associates. At rural health posts, to which the vast majority of malaria patients first turn, diagnosis is similarly based on clinical features only, since laboratory confirmation is often unavailable. In studies carried out in Nigeria, the patient or the mother was correct in diagnosing malaria (as confirmed by demonstration of malaria parasites in the blood film) in about 50% of cases; there was roughly the same percentage of correct diagnoses by peripheral health care workers who had no access to laboratory tests.

Treatment

The treatment-seeking behaviour of each community is very relevant to the success of the case-management strategy. This behaviour is largely determined by people's perception of the relative usefulness of competing care systems. In many parts of Africa, unofficial health care systems and operators exist side by side with the official system and include traditional herbal healers, medicine vendors and spiritual healers. These alternative systems are usually more readily accessible and cheaper than the formal system, and many patients seek treatment from these groups first, turning to the formal system only when they fail.

There is a clear need to improve the formal system so that it becomes more accessible, acceptable and affordable to ordinary people and thus becomes their first choice. Many initially mild cases of malaria become severe and life-threatening because of delays in starting effective treatment as the patient tries one alternative treatment after another. At the same time, the existence and potential usefulness of some of these alternative systems need to be recognized and their operators should be empowered, through training and proper health care delivery orientation, to diagnose and treat malaria correctly.

Availability of drug treatment

Total coverage of all patients needing treatment is only possible if there is an adequate supply of drugs that are effective, safe, tolerable and affordable, if there is an effective distribution system for them, and if they are used rationally. For most of Africa south of the Sahara, chloroquine has, until recently, been the mainstay of malaria drug treatment since it was first introduced into medical practice on the continent in the early 1950s. Unfortunately, in some parts of Africa this drug no longer cures a satisfactory percentage of the patients who use it, so another one has to be used. In some countries sulfadoxine-pyrimethamine has replaced chloroquine as the drug of choice for acute uncomplicated malaria. In others where chloroquine is still the drug of choice, sulfadoxine-pyrimethamine has to be available for the increasing percentage of patients who fail to respond to chloroquine. A recent finding in Nigeria suggests that the combination of chloroquine with an antihistamine such as chlorphenamine increases the percentage of patients cured. This requires further confirmation and may hold out the prospect of prolonging the therapeutically useful life of chloroquine in the African continent.

Both chloroquine and sulfadoxine-pyrimethamine are cheap, well tolerated and readily available. These two antimalarials are essential drugs for which each malaria-endemic country in Africa should have an effective distribution system, ensuring that patients have easy access to the drugs and that the drugs are prescribed and used in a rational way. Packaging and accompanying information should also encourage their correct use. Single-dose packs have been introduced in the public and private sectors in some countries and have been shown to improve compliance, particularly by overcoming the under-dosage that is very common with home treatment. This could also prevent the selling of the drugs in sub-therapeutic dosages by medicine vendors.

A doctor palpates the spleen of a child in the Gambia; an enlarged spleen may be a clinical sign of exposure to malaria. Photo WHO/TDR/S. Lindsay

In the few instances when a mild to moderate uncomplicated malaria case in Africa fails to respond to chloroquine or sulfadoxine-pyrimethamine, it becomes necessary to use one or more of the other available antimalarial drugs. These include mefloquine and halofantrine, which are too expensive for widespread use and have more side-effects than chloroquine and sulfadoxine-pyrimethamine. Amodiaquine, an analogue of chloroquine, has been shown to retain activity against the malaria parasite for some time after chloroquine resistance has developed. Quinine is not recommended for routine use in uncomplicated malaria in Africa because of its cumbersome dosage schedule lasting seven days, and its potential toxicity. In the same way, oral artemisinin derivatives – which have proved effective in other parts of the world – are not currently recommended for monotherapy in Africa because of the potential for misuse. This group of very powerful antimalarial drugs needs to be held in reserve for severe complicated malaria and for some future date when they can be used in combinations that are effective, well-tolerated and able to prevent or delay resistance.

For severe complicated malaria, which in Africa often means cerebral malaria, the drug of choice is quinine given initially intravenously when the patient is in coma and subsequently orally to complete the seven-day treatment course when the patient becomes conscious. One alternative to quinine which gives as good a result is intramuscular artemether. This has the advantage of being usable in peripheral health care facilities that have no capability for intravenous infusion therapy.

Some mortality always results from cerebral malaria, even in localities where the parasite is fully sensitive to the drugs used. The best way to avoid this mortality is to prevent progression of a mild case to a severe one through early diagnosis and the prompt, effective treatment of uncomplicated cases. ■

Professor Lateef A. Salako is Director-General of the Nigerian Institute of Medical R... 6 Edmond Crescent (Off M... Way), Yaba, L...

Treatment outside the health services

Halima Abdullah Mwenesi

Prompt diagnosis and effective treatment of a malaria episode, whether confirmed by a blood test or not, are extremely important. However, many people living in malarious areas do not know how to diagnose the disease and have no access to prompt and effective treatment for it. Nevertheless, self-diagnosis of malaria is almost always followed by some form of self-treatment, with home remedies, antimalarial drugs or both. This is common practice in many countries.

Although the definition of the disease varies in different localities because of the wide variety of symptoms that may appear, fevers, headache, chills, indigestion and general malaise are usually treated as malaria. Self-misdiagnosis of this kind leads to a high level of inappropriate treatment.

Among the main reasons for self-treatment are the lack of access to formal health services (high cost, too far to travel), inadequate services (shortage of drugs in health facilities, long waiting time for consultation) and the easy availability of over-the-counter treatments. Sources of drugs for treating malaria outside health facilities and pharmacies include shops, markets, street vendors, traditional healers and private practitioners. All these sources have potential disadvantages. For example, most shopkeepers and street vendors are not qualified to diagnose and treat, do not know the correct dosages, do not store the drugs correctly, do not know the possible side-effects of combining different medicines, may give substandard or unnecessary drugs, and do not know when a patient needs to be referred to a qualified health professional.

The ways in which people treat themselves for malaria seem chaotic and may even be dangerous, but if carried out appropriately they can save lives.

While private practitioners may be trained and have the right drugs, they tend to charge more and may offer unnecessary medicines for financial gain.

A street vendor of drugs in Ghana. In the absence of regular networks of care and drug distribution, educating the users, vendors and shopkeepers in the proper use of antimalarials can save lives. Photo WHO/Goldschmidt

Delay can be fatal

At the family level, especially where children are suspected to have malaria, mothers and carers may give analgesics or any available antimalarial or other drugs, including antibiotics. The lapse of time between onset of illness and remedial action seems to depend on the perceived cause, the prognosis and the severity of illness. Unfortunately, mothers and other carers very often give drugs of substandard quality, inadequate dosages or simply the wrong drugs. As well as being a problem in itself, this leads to delays in seeking care which worsen the condition and sometimes result in the child's death.

Drug-use practices for malaria on the periphery of the regular health services tend to be chaotic and dangerous, but if they are carried out appropriately they can save lives. Community health workers have been found to be helpful because they are close to the people, know how to diagnose and treat and, more importantly, know when to refer a very ill person to hospital. In addition, an informed community of users, vendors and shopkeepers is needed. This can be achieved through health education specifically targeting all these categories. Clear messages on how to recognize malaria, how to treat it appropriately and when there is need to refer a patient to hospital or a clinic must be emphasized. In addition, people living in malaria-endemic areas need much better health services. Finally, further work is urgently needed on new antimalarial drugs that can be used by communities living beyond the range of regular services. ■

Dr Halima Abdullah Mwenesi is Scientific Coordinator, Kenya Medical Research Institute, Medical Research Centre, P.O. Box 20752, Nairobi, Kenya.

The will to win in Viet Nam

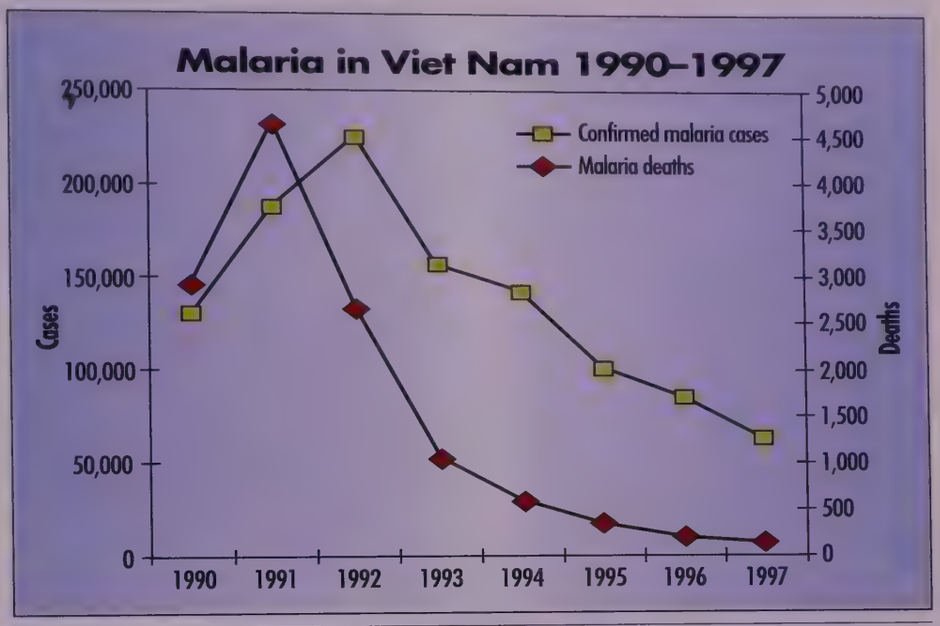
Le Dinh Cong & Allan Schapira

Malaria control in Viet Nam suffered severe setbacks in the 1980s as a result of the general economic decline. Health services deteriorated, DDT was no longer donated by the Soviet Union, resistance to antimalarials developed relentlessly, and people seeking new economic opportunities in forested and hilly areas carried the infection back to parts of the country which had previously been malaria-free. Morbidity and mortality peaked in 1991, and in that year alone 144 epidemics were recorded.

From the early 1990s, economic recovery made it possible to increase financial support for malaria control. Collaboration between industry and researchers led to the local production of artemisinin and related drugs for the treatment of severe and multidrug-resistant malaria. The artemisinin drugs, used for centuries in traditional Chinese and Vietnamese medicine, had been rediscovered by Chinese scientists in the 1970s. In Viet Nam, the introduction of these rapidly acting antimalarials in the general health services has helped to reduce the number of severe cases and deaths from malaria.

The other important development was the introduction of insecticide-impregnated bednets. Trials in Viet Nam indicate that the effectiveness of this method for preventing malaria is comparable to that of spraying the indoor walls of homes with insecticides. The advantages are both economic and ecological, since less insecticide is needed per person protected. The method is also more popular, as it provides protection against bedbugs and other nuisances as well as malaria, and is adaptable to different lifestyles. For example, people who sleep away from home can take their nets with them.

The impregnation of nets is now provided as a free public service to people living in malaria-endemic areas. Nearly 10 million persons are protected by this method in Viet Nam, but not all problems are solved. Some ethnic groups have still not acquired the habit of using mosquito nets. A nationwide evaluation of malaria control in 1995 showed that malaria had gone down in most of the areas where impregnated nets had been introduced but not in all of them. Where the nets had been less effective, the population usually did not know that the purpose of using them was to prevent malaria. Obviously the distribution of nets and insecticide needs to be accompanied by sufficient education, to ensure their correct use.



Malaria cases and deaths have declined rapidly since the revitalization of the national control programme from 1991. Graphic WHO/National Malaria Control Programme, Viet Nam

Government funding for malaria control continued to rise rapidly between 1991 and 1995. Since 1995, foreign partners have greatly increased their contributions to the successful Vietnamese control programme, allowing the Government to give more attention to other health problems such as dengue fever. While the Vietnamese achievements in malaria control are encouraging, it should be noted that the gradual reduction in malaria incidence during the 1990s resembles the reduction which occurred between 1975 and 1984, when the programme relied mainly on house-spraying.

Government commitment has been important and so has international cooperation. In particular, the programme has benefited from the rapid technological advances in other countries, followed by trials in Viet Nam and then large-scale application. This is carried out by a large workforce of trained malaria control staff in a centrally managed structure, collaborating closely with general health services at the periphery. Over the years, apart from the setbacks caused by two major wars, there has been much trial and error, yielding both positive and negative lessons. Technology, training and money have been indispensable, but perhaps the main driving force has been the will to win. Today, malaria control for all groups at risk is an unquestioned imperative. ■

Dr Le Dinh Cong is Chairman of the Steering Committee of Viet Nam's National Malaria Control Programme and Dr Allan Schapira is the WHO Medical Officer responsible for malaria control in Cambodia, Lao People's Democratic Republic and Viet Nam. Dr Schapira's address is c/o The WHO Representative, P.O. Box 52, Hanoi, Viet Nam 10000.

Success in the Solomon Islands

Kevin Palmer

A comprehensive set of measures to protect the population of Solomon Islands from malaria resulted in a 61% reduction in incidence. Photo WHO/S. Yabao

Government commitment and international support to an intensified control programme aimed at making the island republic's capital, Honiara, a healthier place to live in cut the incidence of malaria by more than 76% between 1992 and 1997.

Since 1992, Solomon Islands has made significant progress in reducing its malaria problem, bringing the number of reported cases down by 61%. In 1992 there were 153 359 confirmed cases in a population of about 350 000. This translated into an annual incidence rate of 440 per 1000 population, making Solomon Islands one of the most malarious countries in the world outside of Africa.

By using a carefully selected combination of control strategies, the number of cases was brought down to 72 000 in 1997 (170 per 1000 population). In Honiara, the capital city, the decline has been even more dramatic. In 1992 there were 48 421 microscopically diagnosed cases reported in a population of 45 131 (an annual incidence of 1072 per 1000). By 1997 the number of cases had dropped to 17 569 in a population of 66 507 (an annual incidence of 264 per 1000). That was a decline of 75%.

The success of the Solomon Islands Malaria Control Programme is the result of several factors. First, the total reorganization and reorientation of the Programme that took place in 1993 resulted in the Government giving its full commitment to malaria control. Realistic targets were set, control strategies were selected, a programme for retraining the staff was set up, and commitment from international donor partners was obtained. In 1995, realizing that more than one-third of the total malaria cases were in Honiara, the Government – with special support from WHO – initiated an intensified control programme with the goal of making Honiara a healthier place in which to live and work.

The intensified activities in Honiara included:

- improvements in the availability and quality of diagnosis and treatment of malaria;
- use of insecticide-treated mosquito nets;
- residual spraying of houses;
- ultra low volume spraying in the most problematic areas;
- cleaning of streams and rivers together with the regular application of larvicides to all mosquito breeding sites;
- mass drug administration;
- mass blood surveys followed by treatment and follow-up of positive cases;
- installation of an innovative pipeline to control mosquito breeding in the main river flowing through the centre of town;
- introduction of a computerized malaria information system;
- active surveillance to detect infection in people who were not seeking treatment and to check on the malaria status of visitors and residents returning from other parts of the country.

In the provinces, activities have focused on improving programme management, improving the diagnosis and treatment of malaria, attaining high coverage with insecticide-treated mosquito nets, and spraying houses in the most problematic localities. Not only has this resulted in an overall reduction in incidence of 61%, but in addition, by the end of 1997, four of the eight provinces had annual incidence rates of less than 100 per 1000 population. Crucial to the success of malaria control in the Solomon Islands has been the full support received from both the Government and its many international donor partners. ■

Dr Kevin Palmer is a WHO Malariologist working in the Solomon Islands; his address is P.O. Box 22, Honiara, Solomon Islands.

Oman goes for eradication

A. Beljaev

Environmental conditions and the climate in Oman encourage mosquito breeding, but an active control programme has provoked a dramatic decline in malaria cases over recent years. Photo WHO/A. Beljaev

Oman lies in the south-eastern corner of the Arabian peninsula and, with its low mountains and green valleys, it contrasts with the neighbouring territories of Saudi Arabia and the United Arab Emirates. The climate in central Oman is not as harsh as in the surrounding deserts and this permits the proliferation of malaria vectors. The ecology of malaria in Oman is akin to that in India and, as in that country, the killer species of malaria parasite, *Plasmodium falciparum*, used to be widespread. Until recently, there were severe epidemics with high morbidity and mortality, especially following a period of heavy rains.

The endemicity of the disease in Oman reached its peak in the 1970s, when there were about 300 000 clinical cases each year. At that time, malaria was one of the main impediments to development, and the government was compelled to introduce malaria control as part of its drive for modernization. As a result, the number of laboratory-confirmed cases of malaria was brought down to 37 220 by 1990.

Despite the high endemicity in the past, there are at present fewer breeding places for the vectors in Oman than elsewhere in the tropics, and the country has sufficient resources and a sound infrastructure that can ensure effective disease control. Furthermore, Oman is almost like an island, with sea to the north, east and south and desert to the west. This means that, after the eventual interruption of malaria transmission, it should be possible to screen off the country from importation of the disease from abroad. All these conditions suggest that for this country the eradication of malaria is feasible.

Spraying campaign

In the light of these considerations, Oman adopted a malaria eradication policy in 1991. The main approach has been to make a meticulous inventory of all breeding places and to render them innocuous, mostly by weekly spraying with an insecticide. For this, temephos is used, which is one of the safest and most environment-friendly insecticides available. The success of this approach depends on good operating habits and close supervision. The work is organized in such a way that the whereabouts of every sprayer for a particular day and time is known and their work is constantly evaluated.

Besides the control of mosquito larvae, the early detection and treatment of cases is being maintained. This is not only to reduce suffering and prevent severe disease and death, but also to prevent mosquitos from acquiring the parasite from human carriers. Health education is another very important element for ensuring full participation by the communities concerned.

This programme was put to the test in 1995, when the country experienced a record-breaking rainfall. Despite the risk that this might encourage mosquito breeding, disease transmission continued to fall dramatically, and in 1997 only 129 locally contracted cases were detected. Many more (897 cases) were imported from abroad, mostly from the Indian subcontinent and East Africa. The timely detection and treatment of those imported cases was essential to prevent the re-establishment of malaria in transmission-free areas.

The future of the programme clearly depends on the Government continuing its support, which has so far been unlimited. The crucial moment will come when locally contracted malaria becomes a rarity and the disease apparently ceases to be an important health problem. As the experience of earlier – and failed – eradication programmes has demonstrated, if efforts are weakened at that moment, malaria can rebound from a few residual foci and go on to cause large-scale epidemics in a population that has lost its immunity during the years of low transmission. ■

Dr A. Beljaev is Regional Malaria Adviser, World Health Organization Regional Office for the Eastern Mediterranean, P.O. Box 1517, Alexandria 21511, Egypt.

World Health ■ 51st Year, No. 3, May–June 1998

Cost-effective control in Brazil

Renato d'A. Gusmão

Between 1989 and 1996, Brazil's malaria control programme cost US$ 616 million but prevented 1 830 000 cases and over 100 000 deaths; the reduced incidence led to savings on treatment costs estimated at $ 42.7 million.

Malaria has been endemic in Brazil for most of the last 300 years, but it was only in the early twentieth century that a concerted effort was launched against the disease. The initial emphasis was on reducing mosquito breeding sites close to the expanding industrial towns, and on distributing cinchona bark to treat patients.

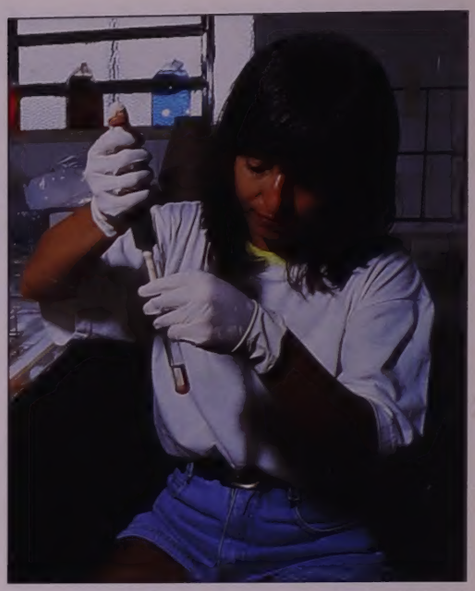
By the middle of the twentieth century, there was heavy investment in a national programme to eradicate malaria from around the cities and from the rural areas. The programme relied heavily on indoor spraying with the newly developed DDT insecticide and the availability of chloroquine for treatment. Early efforts met with considerable success: while the country's population almost doubled in size up to 1974, the number of malaria cases fell to half what it was in 1960.

But then the techniques of house-spraying and active case-detection for supervised treatment became progressively less effective. Malaria cases increased almost tenfold, from 66 481 notifications in 1974 to 614 431 registered cases in 1991. A strategy was tried in the 1980s called "zonification", based on the permanent presence in each highly endemic zone of a national programme worker, responsible for mass treatment and house-spraying with insecticide. The high maintenance costs of this operation soon proved unsustainable.

By 1989, the Ministry of Health had obtained a World Bank loan to support a strengthened malaria eradication drive based on a classical campaign approach by a single institution, the National Health Foundation (NHF). It focused on vector control by indoor spraying with residual insecticides, and active case-detection. It was clear by 1992 that these activities were ineffective, and three factors particularly were blamed: the fact that the disease was mostly transmitted outside the home, the logistic difficulties of reaching the population at risk, and the limited coverage of the health services delivery system. In addition, the massive migration of labour to forested areas of the Amazon Basin drastically reduced the potential effectiveness of the control measures.

The NHF asked WHO's Regional Office for the Americas – the Pan American Health Organization – to step up its technical cooperation so that activities could be reoriented in line with the Global Malaria Control Strategy. This was the first country-wide application of the new Strategy in the Americas. The long-standing objective of eradicating malaria was replaced by the goal of preventing mortality and reducing the socio-economic and morbidity burden of the disease on those at risk.

Alongside a rapid improvement in local health services, there was new emphasis on disease management (particularly early diagnosis and immediate treatment), on targeted preventive and protective measures for individuals, families and communities, including vector control, and on increased capability to detect, control and avoid malaria epidemics. Local and regional health education institutions also targeted such high-risk groups as



Preparing blood samples for analysis in the Amazon Region. Case detection is an important element in Brazil's elimination campaign. Photo WHO/TDR/M. Edwards

mining prospectors, lumber workers and farming families. The number of diagnostic and treatment centres, now integrated into the general health services, expanded between 1992 and 1996 from 618 to 1038.

Over the same period, malaria mortality fell by 20.8% and the *Plasmodium falciparum* incidence rate dropped from 13 per 1000 population exposed to transmission to 8 per 1000. Subsequent evaluation of this programme found that, between 1989 and 1996, the total cost of the control programme was US$ 616 million, while the total number of cases and deaths prevented amounted to 1 830 000 and over 100 000 respectively. The reduced incidence led to savings on treatment costs estimated at $ 42.7 million – a result that amply demonstrates the cost-effectiveness of the control strategy in demographically and ecologically unstable areas of development such as the Amazon region of Brazil. ■

Dr Renato d'A. Gusmão is Regional Adviser, Communicable Diseases Programme, World Health Organization Regional Office for the Americas/Pan American Sanitary Bureau, 525, 23rd Street NW, Washington, DC 20037, USA.

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Publications can be ordered from Distribution and Sales, WHO, 1211 Geneva 27, Switzerland.

A strategy to control malaria

The global strategy on malaria control was agreed on at a ministerial conference in 1992. In *A global strategy for malaria control*, WHO presents the new strategy and explains why it is needed. The book gives technical and practical advice for a renewed attack on malaria that is more realistic and sustainable than earlier approaches. It gives particular attention to disease-oriented programmes that aim to reduce sickness and death.

The complexity of malaria means that there can be no universal formula for control. Yet the disease is both curable and preventable. Thus the book concentrates on general principles that can be used as a guide to choosing appropriate cost-effective measures in various situations. Recommended lines of action draw on what has been learned from decades of experience in combating malaria.

A global strategy for malaria control, *1993 (ISBN 92 4 156161 0) costs Sw.fr. 11.-/US $9.90 (Sw.fr.7.70 in developing countries).*

Implementing the malaria strategy

Following the ministerial conference that agreed the new global strategy on malaria control, a WHO Study Group met to discuss ways of implementing it. *Implementation of the global malaria control strategy* is the report of that Study Group which translates the strategy into a plan of action against malaria leading up to the year 2000. The report explains the implications of the strategy and how it can be put into effect.

Action recommended by the Study Group is based on experience of what works – and what does not work – in different social and epidemiological settings. The report deals particularly with choosing priorities in a particular situation and making sure that resources are used to greatest effect.

Implementation of the global malaria control strategy, *1993, WHO Technical Report Series, No. 839 (ISBN 92 4 120839 2) costs Sw.fr. 10.-/US $9.00 (Sw.fr. 7.00 in developing countries).*

Treating malaria patients

Treating a patient with malaria can be complex. Yet treatment must be given quickly and the consequences of errors can be serious. *Management of severe and complicated malaria: a practical handbook* is a pocket-sized guide that explains the steps of treatment clearly and simply. The 56-page handbook, which is intended for doctors and other medical staff, shows at a glance what signs to look for, what tests to do, what actions to take immediately and what to do later, and what kind of nursing care to give.

Special problems dealt with throughout the book include the tendency of malaria to mimic other diseases, the difficulty of diagnosing the disease in cases of self-medication, the spread of parasite resistance to chloroquine and other drugs, and the need for special precautions in areas where blood may be contaminated with the human immunodeficiency virus (HIV).

The book aims to facilitate rapid decisions and immediate actions. Fold-out flaps on the inside front and back covers guide the correct selection, dosage and administration of antimalarial drugs, and summarize the immediate steps to take when faced with 13 specific complications. There is also a map of chloroquine resistance around the world.

Management of severe and complicated malaria: a practical handbook, *by H.M. Gilles, 1991 (ISBN 92 4 154436 8) costs Sw.fr. 9.-/US $8.10 (Sw.fr. 6.30 in developing countries).*

Forthcoming from WHO

Two new books on malaria are in preparation by WHO:

Bench aids for the diagnosis of malaria and babesiosis
These laminated A4 sheets are aids for the microscopic diagnosis of malaria.

Management of severe falciparum malaria
This will be an updated edition of the handbook *Management of severe and complicated malaria* (see above).

To receive a publication announcement when these books are available (and for a catalogue of all WHO publications on tropical diseases), contact Distribution and Sales, World Health Organization, 1211 Geneva 27, Switzerland.

In the next issue

People depend on animals as a source of food, transport, labour and companionship, but animals can also transmit diseases to humans. The July-August issue of ***World Health*** will look at different aspects of animal health in relation to human health. ■

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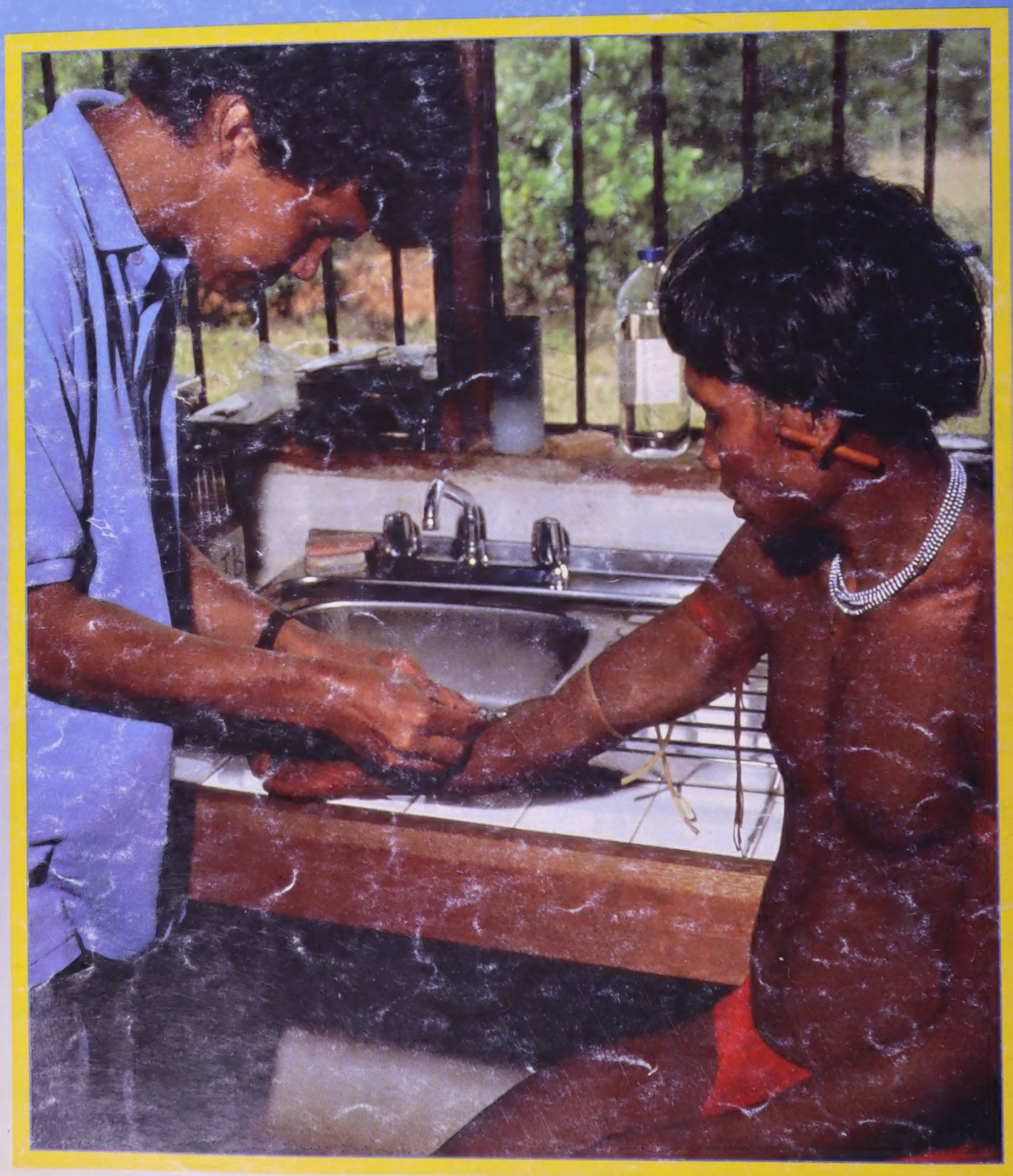
A REMOTE HEALTH POST IN BRAZIL'S AMAZON REGION. IN ORDER TO SUCCEED, MALARIA CONTROL EFFORTS HAVE TO BE ADAPTED TO A WIDE VARIETY OF DIFFERENT SITUATIONS.



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